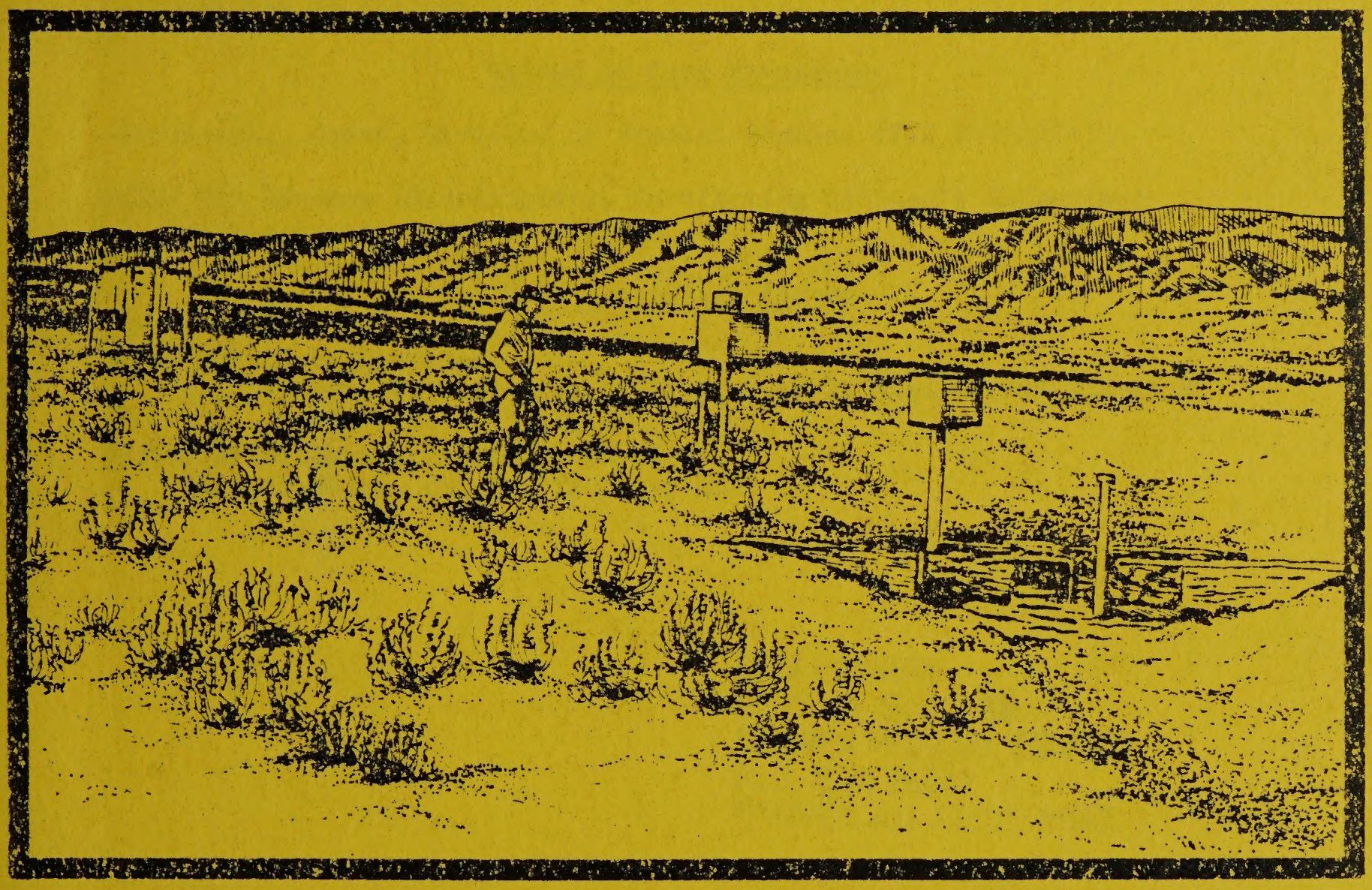
BLM LIBRARY
88018620

1981 WORK PLAN



U.S. Geological Survey &

Bureau of Land Management

GB
658.7
.L362
1981

21013750
ID 88018620

GB
658.7
.L362
1981

Preface

The Bureau of Land Management each year requires data collection and analysis and technical consulting services of its sister agency, the U.S. Geological Survey. For fiscal year 1981 services are requested of the GS's Water Resources Division and Geologic Division (Branch of Coal Resources and Office of Geochemistry and Geophysics).

The Work Plan includes both EMRIA and non-EMRIA work items. Non-EMRIA work items are identified by a separate appropriation code included in each work item description. Agency contacts for the 1981 BLM/GS contract are as follows:

Bureau of Land Management

Herb Runkle, Chief, Division of Special Studies (FTS 234-2374)

Bruce Van Haveren (Hydrologist), Contracting Officer's Authorized Representative (FTS 234-2374)

U.S. Geological Survey

Water Resources Division
Hugh Hudson, Reg. Program Officer, Central Region (FTS 234-4118)

Office of Geochemistry and Geophysics
Richard Ebens, Chief (FTS 234-3715)

BLM LIBRARY
SC-324A, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047

BUREAU OF LAND MANAGEMENT LIBRARY
Denver, Colorado
88018620

BLM LIBRARY
SC-ASAA, BLDG. 20
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO. 80225-0047

TABLE OF CONTENTS

	Page
Preface	i
Water Resources Division	
Summary of BLM Funds	1
Annual Work Plan	2
Alabama	4
Colorado	10
Idaho	24
Montana	26
Nevada	41
New Mexico	45
North Dakota	55
Oklahoma	77
Utah	86
Wyoming	94
Office of Public Land Hydrology	102
Precipitation-Runoff Modeling Project	105
Branch of Regional Geochemistry	107

WATER RESOURCES DIVISION

SUMMARY OF BLM FUNDS
WATER RESOURCES DIVISION

State	EMRIA	Other	Total
Alabama	$ 350,000	-	$ 350,000
Colorado	819,800	$214,900	1,034,695
Idaho	-	11,180	11,180
Montana	871,990	48,500	920,490
Nevada	-	60,000	60,000
New Mexico	210,750	-	210,750
North Dakota	496,530	-	496,530
Oklahoma	466,650	-	466,650
Utah	350,000	192,350	542,350
Wyoming	382,580	7,100	389,680
Central Region			
OPLH	68,900	-	68,900
Modeling Project	23,200	-	23,200
TOTALS	$4,040,400	$534,030	$4,574,425

ANNUAL WORK PLAN

USGS WATER RESOURCES DIVISION AND BLM
Fiscal Year 1981

AUTHORITY

The General Agreement between the Bureau of Land Management (BLM) and the Geological Survey (GS), dated August 15, 1974, is considered the basis for this Work Plan.

PURPOSE

The purpose of this Work Plan is to specify the nature and amount of assistance to be provided by the GS to BLM during FY 81.

SCOPE

This work order includes all services to be provided by the GS under the EMRIA program to BLM in fiscal year 1981 in the States of Alabama, Colorado, Montana, New Mexico, North Dakota, Oklahoma, Utah, and Wyoming. Also included are non-EMRIA work items for the states of Colorado, Idaho, Montana, Utah, and Wyoming.

The GS will provide the services, including personnel, equipment, supplies, and facilities, to conduct water resources investigations in areas designated by the BLM. Services will include installation, operation, and maintenance of surface-water gages, ground-water wells, and climate stations, as well as water-quality data collection and analysis.

PROCEDURE

Fiscal year 1981 is the seventh year of this cooperative effort. Some work that began in earlier fiscal years will be continued in fiscal year 1981, while some projects may be dropped. New studies will begin in fiscal year 1981, some of which will carry into fiscal year 1982 and beyond. These decisions will be made in joint meetings among the GS District and BLM State offices and the Denver Service Center. The annual work plan is developed by D-450 after negotiations with BLM field offices to determine needs and GS field offices to determine capabilities, recommended hydrologic procedures, and for coordination with other studies conducted by the GS in other programs. The development of budgets takes into account the program needs of both agencies and funds available to meet those needs. When mutual interests are strong, funds from both agencies are applied. Funds tabulated in the work order, however, represent only those from BLM.

Field investigative procedures will be standard GS water resources investigation techniques.

REPORTS

Reporting will generally be standard GS report procedures with some deviations that are detailed in the Annual Work Plan.

Semiannual progress reports will be prepared by each Water Resources Division district and routed through the Central Region to BLM. Due dates for these reports will be April 15, 1981, and September 1, 1981.

In addition, a separate report on the progress of the precipitation-runoff modeling efforts in all states, covering the status of the small watersheds calibration, will be prepared jointly by the Precipitation-Runoff Modeling Project (USGS) and the EMRIA staff (BLM) and submitted to D-450 by September 1, 1981.

FUNDING

BLM will reimburse GS for actual expenses incurred in providing the service covered in this work order, not to exceed $4,574,425 upon receipt of SF 1081. Details of cost items for each study in each state are presented in the Annual Work Plan.

Alabama

ALABAMA

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT		EMRIA FUNDS
Hydrologic Surveillance and Watershed Modeling of Potential Coal Mining Areas in North-Central Alabama		
A. Hydrologic Surveillance		$151,000
B. Hydrolgic Modeling		59,000
	Total:	$210,000
Hydrogeologic Evaluation of Potential Mining Areas in Northeast Alabama and South-Central Alabama		40,000
*Analysis of Existing Hydrologic Data in Central Appalachian and Eastern Interior Coal Regions		70,000
*Analysis of Existing Hydrologic Data in the Western Interior Coal Region		30,000
	Total:	$350,000

*These studies are not located in Alabama but will be coordinated by the ESO along with Alabama.

ALABAMA

I. Hydrologic Surveillance and Watershed Modeling

A. Hydrologic Surveillance in North-Central Alabama

1. Location: The Warrior Coal Field is the principal area of study. It includes parts of Walker, Fayette, Tuscaloosa, Jefferson, and Cullman Counties, about 4,000 sq mi. Principal basins monitored are Yellow, Turkey, Bear, Blue, Trinity, and Dorsey Creek basins in Tuscaloosa, Walker, and Cullman Counties.

2. Objective: Collect and interpret basic data on water resources to aid BLM in its responsibility for preparing EIS's and in its planning and managing coal reserves underlying Federally controlled mineral rights. The primary objective requires the accomplishment of three subordinate objectives that are:

a. Determination of the effect coal mining will have on the hydrology.

b. Development of predictive tools for assessing mining impacts on the hydrology.

c. Assessment of reclamation practices.

The latter assessment, because of changing laws during the life of the project, will be made largely by reviewing the literature and evaluating data obtained by coal hydrology projects that have monitored areas reclaimed under old laws.

3. Procedures: Standard U.S. Geological Survey methods will be used to collect streamflow, water quality, biologic, sediment, ground water, and precipitation data.

a. Surface water and its quality.

(1) Collect data (semiannual) at 30 sites draining coal-mined basins distributed in the Warrior Coal Field. Data base is required to verify and improve the reliability of empirical predictive tools (regression equations) developed for assessing mining impacts on surface-water quantity and quality.

(2) Collect data at 10 partial record stations in mined basins, data to be used in evaluating the effect of mining on the hydrology.

b. Sediment: Sediment data collection will be continued at automated and partial record stations.

c. Ground water and its quality.

(1) Water-level measurements, water sample collection, and aquifer hydraulic characteristics testing will be made in all test wells in the observation well network. Data will be used to determine the magnitude, timing, and dispersion of pollutants in drainage recharged into underlying aquifers in mined areas.

(2) Add selected test wells near mined areas drilled by the Conservation Division, USGS, as part of their work to estimate coal reserves and by the Geological Survey of Alabama as part of the overburden analysis program.

d. Biology: Continue biologic sampling program at four sites located in streams draining mined areas. Biologic sampling will consist of measuring parameters that are indicative of the effects of acid mine drainiage. Sampling in riffle areas is to be done monthly.

e. General.

(1) Continue scheduled precipitation data collection at existing network of 15 sites to better relate precipitation to ground water-surface water revelations and to aid in facilitating small basin watershed modeling (see item B).

(2) Continue to tabulate and interpret on a current basis all data collected as a part of this project and similarly related projects on an effort to improve techniques for predicitng effects of mining on the hydrology.

(3) Continue contracting aerial photography to define degree of mining and land use changes in principal basins monitored and other land under federal mineral ownership.

(4) Continue coordination with other agencies to avoid data collection duplication and to inform them of project objectives and activities.

4. Report Products: All collected data is placed in computer storage on an ongoing basis and will be published in data report, "Water Resources Data for Alabama." An interpretive report on the hydrology of the study area and covering the period of time from October 1976 through July 1980 will be completed by September 30, 1981. The report will define baseline hydrologic conditions, effects of mining on hydrology, and hydrologic models developed for predicting stream quality and quantity changes resulting from surface mining (see item B). Where feasible, project findings will be incorporated into papers prepared for presentation to other government agencies, universities, and professional organizations.

5. Reports Completed: Puente, Celso, Newton, J. G., and Hill, Thomas J., 1980, Hydrology of Selected Basins in the Warrior Coal Field, Alabama - A Progress Report: U.S. Geological Survey Water Resources Investigation 80-22, 62 p.

6. Relationship to Other USGS Studies: This project benefits from and supplements data collection at about 200 streamflow and water-quality stations being monitored in the coal areas of Alabama. Data collection under this study will be useful in defining premining hydrologic conditions and the effects of mining on hydrology in ungaged basins in the coal areas of Alabama.

7. Distribution of Funds:

Salaries	$ 81,000
Travel	3,000
Aerial Photography	8,000
Data Processing	3,000
Laboratory Services	52,000
Equipment and Supplies	4,000
Total:	$151,000

B. Hydrologic Modeling

1. Location: Yellow, Bear, and Blue Creek basins in northern Tuscaloosa County, Trinity Creek in Walker County, and Dorsey Creek in Cullman County.

2. Objectives.

a. Continue to develop and verify rainfall-runoff models for simulating streamflow; develop and verify water quality models for simulating solute loads.

b. Derive techniques to estimate water quality changes and sediment yield resulting from strip mining in ungaged basins in north-central Alabama.

3. Procedures: Model development will be based on calibration of measurable climatic, hydrologic, and physical features to achieve acceptable synthetic streamflow. When fully documented it will be useful in estimating soil-moisture storage relationships, infiltration, and surface runoff; it will improve hydrologic data transfer to ungaged sites in the Warrior Coal Field.

   Bear Creek and Yellow Creek basins represent undistrubed areas in contrasting hydrologic settings within the coal field. A gaging station in each basin is instrumented for continuous monitoring of streamflow, temperature, specific conductance, precipitation, and daily suspended sediment. These stations are supplemented by a meteorological station, 7 recording rain gages (see items A), and 16 soil moisture monitoring sites. Similarly, three automated gaging stations monitoring actively mined basins will be added to the study in order to expand the modeling effort to mined areas. The added sites are Blue Creek near Oakman, Dorsey Creek below Arkadelphia, and Trinity Creek near Carbon Hill.

   These sites will provide test cases for demonstrating model application in estimating effects of strip mining on the hydrology of mined watersheds.

   Model calibration and testing during FY 81 will be based on four years of data from undisturbed basins and two years of data from mined basins.

   A water quality model based on empirical regression relationships will be added to the watershed model as a subroutine module. It will be useful for assessing and/or predicting water quality changes in streams impacted by surface strip mining.

4. Report Products: Data collected is placed in computer storage and is available to other agencies and organizations. Study results including model concepts, procedures, simulation runs, and reliability will be included in a report prepared and submitted to the Denver Service Center EMRIA Staff by September 30, 1981 (see item A).

5. Relationship to Other USGS Studies: This project benefits from and supplements other programs in the Alabama District. The study will result in the development of a numerical model useful for assessing and/or predicting cumulative impacts of mining.

6. Distribution of Funds:

Salaries	$44,000
Travel	6,000
Data Processing	8,000
Equipment and Supplies	1,000
Total:	$59,000 1/

II. Hydrologic Evaluation of Coal Areas in Northeast Alabama and Lignite Region in South-Central Alabama

A. Regional analysis of existing hydrologic data in Federal coal ownership areas of Alabama not included in the North Central Alabama Land Use Study (i.e., NE and South Central Alabama). Analysis should center on precipitation, runoff model transferability, and additional data needs for coal activity planning and necessary lead times for site specific data collection. The report should evaluate hydrologic prediction capabilities resulting from OSM, BOM, USFS, and DOE activities in this area.

B. Funds: $40,000

III. Analysis of Existing Hydrologic Data in Federal Coal Ownership Areas of the Central Appalachian and Eastern Interior Coal Regions

A. Analysis should center on precipitation, runoff model transferability, and additional data needs for BLM coal activity planning and necessary lead times for site-specific data collection. The report should evaluate hydrologic prediction capabilities resulting from OSM, BOM, USFS, and DOE activities in this area.

B. Funds: $70,000

IV. Analysis of Existing Hydrologic Data in Federal Coal Ownership Areas of the Western Interior Coal Region (Arkansas)

A. Analysis should center on precipitation, runoff model transferability, and additional data needs for BLM coal activity planning and necessary lead times for site-specific data collection. The report should evaluate hydrologic prediction capabilities resulting from OSM, BOM, USFS, and DOE activities in this area.

B. Funds: $30,000

1/ Does not include salary of one BLM, WAE, hydrologist-modeler who will be assigned to the project.

Colorado

COLORADO

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA	OTHER (4340) SALINITY PROJECT	OTHER (4340) STATE
Hydrologic Modeling	$167,300	---	---
Ground-Water Studies			
Coal-Bearing Aquifers	150,000	---	---
Hydrology and Reclamation Potential of Coal Spoil Piles	133,000	---	---
Hydrologic Characterization			
North Park	60,500	---	---
Raton Mesa	89,000	---	---
Yost Area	100,000	---	---
Collom Gulch	50,000	---	---
Synoptic QW Program			
Yampa River Valley	70,000	---	---
Colorado Salinity Program			
Evaluation of Salinity Potential of Mancos Shale Lands	---	$ 20,305	---
Water-Quality Stations	---	121,390	---
Operation of BLM Stations in San Luis Valley (CO-050-4340-5225)	---	---	$39,900
Hydologic Investigation of Badger Creek (CO-050-4340-5225)	---	---	33,300
TOTALS:	$819,800	$141,695	$73,200

TOTAL FOR THE STATE OF COLORADO: $1,034,695

COLORADO

I. Hydrologic Modeling

A. Objectives: To define hydrologic system of the basin, interrelation of surface-water flow, ground-water movement, precipitation, and climate. The availability and quality of surface and ground water will also be defined. This information will be related to present and future mining operations to assess effects of mining on basin hydrology, and it will provide data for the total mining assessment.

For FY 81 the hydrologic monitoring program will be continued. Data on surface-water quantity and quality and area climate will be collected. Initial hydrologic modeling efforts in 1979 concentrated on evaluating input data to the model and organizing data in the computer to be compatible with the model. Some analysis on several parameters is needed to define values for missing data; this will be ongoing. In addition, initial model runs will be made and are being made with as much data as possible. Therefore, all the study watersheds in the Yampa Valley (sites 1, 2, and 3) are being considered.

Calibration of the model for sites 1 and 2 was begun using the water years 1976 to 1978.

Sampling for suspended trace metals was accelerated at each of the study watersheds. Sufficient data were probably obtained during the high-flow season to complete the analysis of the water-quality characteristics of these basins. Some reconnaissance sampling will be initiated in FY 81 in order to identify transferability of the relations developed in the study watersheds.

B. Study Watersheds

1. Foidel and Middle Creek: Discharge, water temperature, and specific conductance are continuously monitored at three surface-water gaging stations. Monthly sediment samples are at the upper Foidel Creek and the Middle Creek stations, and sediment samples at the lower Foidel Creek station are collected by an automatic suspended-sediment sampler. Routine water-quality sampling will be reduced in order to provide some reconnaissance sampling on nearby streams.

A climatological station operated on Middle Creek measures precipitation, air temperature, relative humidity, soil temperature, wind, and solar radiation. A second precipitation gage is operated on the rehabilitation study area, and a third precipitation gage is installed at the mouth of Foidel Creek. Snow course data are also being collected.

Distribution of Funds:

Salaries	$27,000
Travel	3,100
Vehicles	3,000
Operation and Maintenance of Gages (including data storage)	10,000
Laboratory Analyses	12,000
Data Processing and Modeling	3,800
Total:	$58,900

2. Taylor, Wilson, Jubb Creek Basin: Discharge, water temperature, and specific conductance are continuously monitored at Wilson, Taylor and Jubb Creeks, and operation will continue. An automatic suspended-sediment sampler is installed at the Wilson Creek station. Routine water-quality sampling will be reduced to provide some reconnaissance sampling of surrounding basins.

   Air temperature, relative humidity, precipitation, soil temperature, wind, and solar radiation are measured at the climatological station operated in Wilson Creek basin. A second precipitation gage is operated in the headwaters of Wilson Creek. Snow course data are also collected.

   Distribution of Funds:

Salaries	$21,300
Travel	2,100
Vehicles	3,000
Equipment (replacement)	800
Operation and Maintenance of Gages (including data storage)	10,000
Laboratory Analyses	12,000
Data Processing	2,700
Total:	$51,900

3. Hayden Gulch: For FY 81 the hydrologic monitoring program will be continued with data collected on surface-water quantity and quality, and area climate.

   Hayden Gulch, between Foidel-Middle and Taylor-Wilson Creeks, has been chosen to complete the hydrologic network for northwestern Colorado.

   Hubberson Gulch and Watering Trough Gulch were selected as basins with proposed coal development. Stokes Gulch, selected as being representative of the dryland-farming areas of the region, will provide data to compare the hydrologic impacts of coal development with those of Yampa Basin agriculture development.

A surface-water gaging station, installed on Stokes Gulch, will be continuously monitored for discharge, water temperature, and specific conductance data. Monthly water samples will be collected and analyzed for major chemical constituents, while quarterly water samples will be collected and analyzed for major constituents and trace metals. Monthly sediment samples will be collected at the Hayden Gulch stations. Sediment samples at the Stokes Gulch station are collected by an automatic suspended-sediment sampler.

Distribution of Funds:

Salaries	$30,000
Travel	3,500
Vehicles	3,000
Operation and Maintenance of Gages (including data storage)	6,000
Laboratory	12,000
Data Processing	2,000
Total:	$56,500

C. Hydrologic Modeling Total Funding: $167,300

II. Ground-Water Studies, Coal-Bearing Aquifers in Colorado

A. Location: Colorado

B. Objectives

1. The hydraulic characteristics and the water quality of the major zones of importance in areas of potential coal mining will be defined. The zones will include the alluvium, the overburden, the coal seams, and the underburden.

2. The study will interpret data from areas of local interest as data become available. These local evaluations will then be combined for regionalized interpretations of aquifer hydraulic and chemical characteristics.

3. Several different tests have been used to define aquifer hydraulic characteristics. Data will be gathered to determine the degree of correlation between four types of tests. This information will then be useful for evaluating the degree of accuracy of results from tests at various locations using these various testing methods. The tests that will be compared are: an aquifer test, a recovery test, an injection test, and a slug test.

C. Report Products

1. As data become available, reports wil be published for areas of localized study. These reports will describe the hydraulic characteristics and the water quality of the lithologic layers at the local study sites. The report will be interpretive in nature rather than just a reporting of basic data.

2. A report will be written which describes and evaluates aquifer testing, procedures, and water-quality sampling techniques for different lithologic layers. This report will then act as a reference for both Survey use and for use by other interested parties.

3. A regionalized report will be published when sufficient data are available. This report will show potentiometric surfaces and water quality for the lithologic layers of interest.

D. Distribution of Funds:

Salaries	$ 43,300
Travel	14,600
Vehicles	8,000
Laboratory Costs	11,000
Drilling and Aquifer Testing	49,100
Computer Costs	5,600
Equipment	18,400
Total:	$150,000

III. Hydrology and Reclamation Potential of Coal Spoil Piles

A. Location: Routt County, Colorado

B. Objectives: Three-fold. First, the hydrologic characteristics of coal spoils piles will be defined, and the quantity, quality, and timing of water movement through the spoils will be examined and compared to the same parameters for undisturbed basin areas. Hydrologic data collected will be used to develop a model to predict impact of coal development on the quantity and quality of water leaving a mined basin. In addition, the model will aid in assessing reclamation potential of disturbed areas by providing a complete annual water balance for those specific basin areas.

The second objective will be assessing use of cuttings from holes drilled in undisturbed areas to predict the water-quality changes that will occur after mining these areas. Water-quality changes in existing spoils piles will be compared to quality changes in water passed through a column

of cuttings from adjacent areas. This technique would provide a relatively inexpensive method for predicting water-quality changes in areas to be mined. These data would then be used in the hydrologic simulation model to predict the impact of mining on total basin hydrology.

The third objective is to examine effects of reclamation procedures on spoils-piles hydrology. Different land-surface treatments and vegetative covers will be applied and evaluated to determine their effectiveness in reclaiming disturbed areas, their specific water requirements, and their water-quality impact.

Spoils-piles hydrology is monitored using a combination of lysimeters (installed in the upper 8 feet of the spoil profile) and observation wells. Five lysimeters are installed in a reclaimed spoils area and 4 sets of 6 porous cup lysimeters are installed in an undisturbed area. Soil-water regimes within the lysimeter and adjacent areas are monitored using access tubes and a neutron soil-moisture probe.

Three holes are drilled in the existing spoils pile to total mined depth (about 50 feet), and 4 holes have been drilled to a mined coal depth in adjacent undisturbed areas. All holes will be completed as observation wells and periodic water samples will be collected for analysis of major chemical constituents and selected trace metals. Water-quality changes within the total depth of spoils will be determined from these samples.

The Hydrology of Coal Spoils Piles project has been operating since 1976 and operates 8 ground-water wells in the immediate area. Due to the large financial investment for equipment and the fact that all equipment is in place and operational, it is recommended that the project be continued for at least 2 more years. This would add valuable definition to any trends toward a steady state. After trends have been established it would be useful to continue the project on a reduced basis for monitoring long-term effects (3-5 years). The water-quality sampling work which was previously done by the Ground Water Project (see Section II) will now be done on this project.

As of FY 80 additional studies were being performed at the mine site, monitoring spoil-pile water quality in the saturated zone and water movement in the unsaturated zone. Three ground-water observation wells and three soil-water access tubes monitor soil water content in the unsaturated zone to spoil-pile depth. The wells have continuous water-level recorders in place, and water-quality samples are being taken. A study report will be available at the end of FY 82.

C. Report Products: A publication, planned for 1983, will report all data collected, procedures developed, data analyzed, and models developed.

D. Distribution of Funds:

Salaries	$ 73,000
Travel	8,800
Vehicles	6,900
QW Samples	23,000
Computer	4,300
Installation, Operation and Maintenance of Data Collection Equipment (including data storage)	17,000
Total:	$133,000

IV. Hydrologic Characterization of North Park

A. Location: Jackson County, Colorado

B. Objective: To define hydrologic system of the study area, interrelating surface flow, ground-water movement, precipitation, and climate. The availability and quality of surface water will also be defined. Ground-water data, available from the ground-water level monitoring program, will be related to present and future mining operations to assess the effects of mining on basin hydrology.

An intense data-collection program, begun at the two EMRIA sites on the Canadian River following their installation, is obtaining continuous records of streamflow, sediment, discharge, water temperature and specific conductance. Water-quality data collection will be reduced in order to provide some reconnaissance sampling in the surrounding area.

A site-specific study was begun in April 1979 in the McCallum lease area, where the first lease will be let. The site-specific study should be continued to assess any hydrologic changes associated with the mining. A streamflow station and two rain gages installed and operated on Williams Draw during FY 79 will be continued. Snow courses are also being run.

A climatological station installed in the Canadian River study area in 1979 will be continued. Data collected are temperature, soil moisture, wind run, and precipitation.

C. Report Products: All surface-water data will be published annually in "Water Resources Data for Colorado." An interpretative report covering the Coalmont and Canadian River areas will be published at the conclusion of the study in 1982-83.

D. Distribution of Funds:

Salaries	$22,000
Travel	7,000
Vehicles	3,000
Equipment	1,500
Laboratory Analyses	12,000
Operation and Maintenance of Gages (including data storage)	12,000
Report--EMRIA Site Study	3,000
Total:	$60,500

V. Hydrologic Characterization of Raton Mesa

A. Location: Las Animas County, Colorado

B. Objective: For FY 81 the hydrologic monitoring program will continue operating the detailed site-specific study areas. These areas include: Mulligan, Carpiro, and Molino Canyons.

A rainfall-runoff model will be calibrated during FY 81 for each of the three study basins. A similar snowmelt model will not be implemented for the basins because of minimal snowpack or snowfall events. Channel-geometry data will also be collected at the three basins and at other stream-gage stations in the general area. The channel-geometry data will be used initially to help provide predictive relationships for flow characteristics for the three gaged basins and also other nongaged basins in the area.

A climatological station will continue in operation at the Molino Canyon site, but the Mulligan Canyon site operation will be terminated. The Mulligan climatological station was terminated because of the small number of large snowstorm events which have occurred in the study area during the two-year study existence. Water-quality sampling, primarily suspended trace metals, will be continued at all sites. Because of the fast stream response, less than one hour, observers will be used to help collect the water-quality samples.

C. Report Products: All data will be published annually in "Water Resources Data for Colorado." An interpretive report on channel geometry and flow-characteristic relationships and also an interpretive report on the rainfall-runoff basin modeling results will both be initiated in FY 81.

D. Distribution of Funds:

Salaries	$32,900
Travel	5,000
Equipment	5,400
Laboratory	25,700
Operation and Maintenance of Stations (including data storage)	15,000
Computer Costs	5,000
Total:	$89,000

VI. Hydrologic Characterization of the Yost Area, Yampa River Valley, Colorado

A. Location: Routt County, Colorado

B. Objective: The study will define and interpret the undisturbed natural hydrologic regime of an area which is to be strip mined at some later date.

The purpose of the study is to define the hydraulic and the hydrologic characteristics of shallow or alluvial aquifers, overburden aquifers, underburden aquifers, and the interaction of these aquifer systems to each other and to surface water.

C. Instrumentation: The proposed mine is located 8 mi south of Hayden, Colorado, within the Sage Creek drainage. Along Sage Creek and Grassy Creek, sets of three wells drilled in the alluvium will continue to be monitored.

There will also be two or three sites selected for aquifer evaluation by pump testing. For each well site, a schedule of water-level measurements and water-quality sampling will be designed. Water samples will be analyzed for major cations, major anions, and trace metals. At one or two sites, continuous recorders will be placed on wells.

Approximately 10 soil-water tubes will be installed at different soil and vegetation ecological units within the mine site. A neutron probe will be used to measure the soil-water content. Soil cores will be obtained for gravimetric determination of soil-water content in order to calibrate the neutron probe. Also, soil samples will be obtained for geochemical analysis.

A stream gaging station with a flume will be installed at the mine boundary where Sage Creek flows off of the mine property. Water-quality samples and sediment samples will be obtained at this location. A staff gage will be installed at the point where Satge Creek enters the mine site, and seasonal water-quality and sediment samples will be obtained. Crest-stage gages will be installed at various locations on ephemeral streams.

A climate station will be established in the basin to be mined. Precipitation; maximum, minimum, and mean daily temperature; relative humidity; solar radiation; wind speed; barometric pressure; and evaporation will be monitored at this site. Two recording precipitation gages will be installed at a low and high elevation in the basin. Snow courses will be run at these sites, and snow-quality samples will be obtained. Two other appropriate sites for snow courses will also be selected.

D. Distribution of Funds:

Salaries	$ 35,000
Travel	7,000
Vehicle	8,800
Equipment	5,300
Computer	2,600
QW (SW & GW)	26,300
Construction	4,400
Miscellaneous Supplies	3,500
Contractual Services	7,100
Total:	$100,000

VII. Hydrologic Characterization of Collom Gulch Area, Yampa River Valley, Colorado

A. Location: Moffat County, Colorado

B. Objective: The study will define and interpret the undisturbed natural hydrologic regime of an area subject to lease for coal mining at some later time. Data collected is primarily reconnaissance in nature and aimed at describing the general hydrology of the area.

C. Reports: The interpretation of the hydrologic data will be written as a chapter for a larger report on the natural environmental situation of the site and probable impacts due to coal mining published by BLM.

D. Distribution of Funds:

Salaries	$11,000
Travel	2,000
Water Quality (SW & GW)	17,000
Ground Water Observation and Testing	15,000
Surface Water Reconnaissance	5,000
Total:	$50,000

VIII. Synoptic Water-Quality Program for the Coal Region of the Yampa River Valley, Colorado

A. Location: Routt and Moffat Counties, Colorado

B. Objectives

1. To collect data on the dissolved chemistry of a number of small watersheds throughout the area south of the Yampa River.

2. To compare absolute values and relationships already developed for the six stations with longer term record.

3. To identify regions, if they exist, of homogeneous dissolved water chemistry based on the comparisons made in objective 2. Data collected will be instantaneous discharge, field parameters, and the major dissolved ions. Sampling will be repeated at each site to obtain approximately eight samples at various discharges. Regression relations between specific conductance and each dissolved constituent for each site will be developed. These individual ion relations at a site are then statistically compared among sites to group the basins into regions.

C. Report Products: An Open-File Report will be written interpreting the relations and regions identified at the end of data collection.

D. Distribution of Funds:

Salaries	$30,000
Travel	8,000
Vehicles	7,000
Equipment	3,000
Laboratory	20,000
Computer	2,000
Total:	$70,000

IX. Colorado Salinity Program

A. Evaluation of Salinity Potential of Mancos Shale Lands

1. Location: Three study sites--(1) observation reservoir 4-A, Prairie Dog Site; (2) observation reservoir No. 12, Middle Basin Site; (3) observation reservoir No. 2-A, West Twin Site; in Badger Wash near Mack, Colorado.

2. Objectives

a. Operate the gages April 1 through October 31 each year, collect samples, tabulate the streamflow, water-quality, and rain-gage data. The streamflow gages will be operated on a 5-minute punch interval (with peak-stage indicator). The water sampler will be set to collect a sample every 5 minutes during the runoff period. It is estimated that about 10 samples per site be taken after the first runoff event and three samples per site for approximately three other storms per year will be collected and analyzed.

b. Run topographic survey of each reservoir at each runoff season end.

c. Equipment purchased to aid this contract shall become BLM property at the study end.

3. Report Products

a. Provide BLM with copies of all tabulated data as it is completed. All discharge and water-quality data will be published annually in "Water Resources Data for Colorado."

b. Data from total rainfall, runoff, sediment yield and water quality carried into the reservoir for each site will be compiled and summarized, and then submitted to BLM.

4. Distribution of Funds:

One Rain Gage (installation and O&M)	$ 1,650
Salaries	8,335
Travel	770
Vehicles	800
Supplies and Equipment	750
Data Processing	8,000
Total:	$20,305

B. Colorado Water-Quality Stations

1. Location: Nine gaging stations--two on West Salt Creek, two on Potter Creek, one on West Gypsum Creek, one on Vermillion Creek, two on Onion Creek, which flows out of Fisher Valley in Utah, and one on Salt Creek, which flows out of Sinbad Valley in Colorado.

2. Objectives: Each station consists of a digital water-level recorder to measure stream stage and a Manning sampler to obtain water quality and sediment samples. A stage-discharge relationship will be developed for each site from current and slope-area measurements. Each station will be inspected biweekly with streamflow measurements and water-quality samples obtained at least monthly. These stations will provide data on streamflow quantity and the chemical character of the water in these streams.

   The station location on the Gypsum Valley site will be moved out of the flood plain several hundred yards upstream and placed on the opposite side of the channel. A recording rain gage will be placed in each of five gaged watersheds in western Colorado. Add a two-parameter minimonitor (electrical conductivity and temperature) to each of nine gaging stations to be selected by BLM.

3. Report Products: Provide BLM with copies of all tabulated data as it is completed. All discharge and water-quality data will be published annually in "Water Resources Data for Colorado."

4. Distribution of Funds:

Five Rain Gages (installation and O&M)	$ 8,250
Operation of Nine Surface-Water Stations @ $2,900	26,100
Operation of Nine Water-Quality and Sediment Stations @ $3,600	32,400
Quality of Water Laboratory Analysis	13,860
Installation of Nine Minimonitors at Existing Gaging Stations	11,850
Partial Year Operation of the Nine Minimonitors	24,700
Relocation of One Gage	4,320
Total:	$121,390

X. Operation of BLM Stations in San Luis Valley

A. Location: Eight study sites in San Luis Valley: (1) two reservoir sites--change in contents, (2) four reservoir sites--inflow, (3) two daily stream-flow sites on San Luis Creek. Recording rain gages at seven sites and miscellaneous rain gages in basins.

B. Objective: To determine effects of changes in land use on the runoff from the small drainage areas. Daily flow and rainfall will be tabulated for the six reservoir sites. Two streamflow sites and one rainfall site are located on San Luis Creek to monitor runoff in this area.

C. Distribution of Funds (CO-050-4340-5225):

Salaries	$24,500
Travel	1,400
Vehicles	1,400
Supplies and Equipment	9,500
Data Processing	3,100
Total:	$39,900

XI. Hydrologic Investigation of Badger Creek

A. Location: Badger Creek, tributary to Arkansas River.

B. Objective: Determine surface-water quantity and quality characteristics of Badger Creek watershed.

C. Funds: (CO-050-4340-5225)

Total: $33,300

Idaho

IDAHO

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA	STATE (4340)
O & M Gaging Stations		
Herd Creek (13297597)		
Lolo Creek (13339500)	---	$ 7,980
O & M Gaging Stations		
Birch Creek (13117020)		
Birch Creek (13117030)	---	3,200
Totals:	---	$11,180

IDAHO

I. Operation and Maintenance of Four Gaging Stations

A. Location

1. Herd Creek
2. Lolo Creek
3. Birch Creek - (2) partial-year records

B. Data Collection: Began January 1980 and to continue for a five-year period.

C. Reports: To be published in the USGS "Water Resources Data for Idaho."

D. Funding (ID-930-4340-5273):

Two stations @ 3,990		$ 7,980
Two stations @ 1,600		3,200
	Total:	$11,180

MONTANA

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA	OTHER (4340)
Hydrologic Characterization		
A. Streamflow and Surface Water Quality	$221,690	
B. Suspended Sediment	8,500	
C. Ground-Water Levels	36,100	
EMRIA Site Studies	256,900	
Salinity Modeling of Tongue River	34,900	
Network Analysis	17,300	
Channel Geometry	13,000	
Runoff Characteristics	37,500	
Stream-Reponse Modeling	58,700	
Aquifer Characteristics and Mine Spoils Research	187,400	
Willow Creek Flood Routing Model		18,500
Reservoir Limnology		30,000
Totals:	$871,990	$48,500

TOTAL for State of Montana: $920,490

MONTANA

I. Hydrologic Characterization of Southeastern Montana Coal Areas

A. Network Maintenance of Stream-Discharge and Water-Quality Monitoring Sites

1. Objectives: Collect streamflow and water-quality data at key locations to supplement other programs. The data is essential in defining runoff from potential impact areas, determining streamflow characteristics, and providing a data base from which future changes can be analyzed.

2. Procedure: Standard U.S. Geological Survey methods of surface-water and quality-water data collection will be used to obtain data at the following stations:

Streamflow

East Fork Trail Creek (2 stations)
Beaver Creek near Wibaux
Cherry Creek near Terry
Hanging Woman Creek near Birney
Otter Creek near Ashland

Surface-Water Quality
(*includes specific conductance)

Rehder Creek near Klein
Halfbreed Creek near Klein
Musselshell River near Roundup
East Parrot Creek near Roundup
West Parrott Creek near Roundup
Fattig Creek near Delphia
East Fork Armell's Creek near Colstrip
Armell's Creek near Forsyth*
Rosebud Creek at Kirby
Rosebud Creek near Colstrip
Snyder Creek near Brandenberg
Rosebud Creek at Mouth near Rosebud*
Spring Creek near Decker
Tongue River below Tongue River Dam*
East Fork Trail Creek
Prairie Dog Creek near Birney
Hanging Woman Creek below Horse Creek
Otter Creek near Otter
Otter Creek below Fifteen Mile Creek near Otter
Home Creek near Ashland
Tongue River below Brandenberg Bridge near Ashland*

Pumpkin Creek near Miles City*
Glendive Creek near Glendive
Cottonwood Creek near intake
Beaver Creek near Wibaux
Trail Creek near Otter
Corral Creek near Otter
Horse Creek near Birney
Waddle Creek near Otter
Hanging Woman Creek near State Line
Locate Creek near Ismay
Cow Creek near Colstrip
Hardscrable Creek near Andes
Fox Creek near Lambert
Lone Tree Creek near Sidney

3. Report Products: Basic records from streamflow and surface-and water-quality sites will be submitted to BLM annually or as mutually agreed upon. Records will be published by the USGS in an annual report, "Water Resources Data for Montana." The data will be used by the USGS in preparing interpretive reports described in other parts of the work plan.

4. Relationship to Other USGS Studies: This program will supplement and be correlated with other USGS programs of streamflow and surface- and water-quality data collection. Other stations operated in this area include:

Rosebud Creek at reservation boundary at Kirby
Redwater River at Circle
O'Fallon Creek near Ismay
Redwater Creek near Vida
Mizpah Creek near Mizpah
Nelson Creek near Van Norman
Prairie Elk Creek near Oswego
Squirrel Creek near Decker
Burns Creek near Savage
Half Breed Creek near Roundup
Sarpy Creek near Hysham

5. Distribution of Funds:

Salaries	$ 94,200
Lab Services	46,900
Travel	56,300
Supplies	7,400
Data Processing	16,890
Total:	$221,690

B. Sediment Data Collection

1. Objectives: Collect sediment data downstream from areas where problems may be encountered from lease areas. The data is essential in defining present sediment loads from which future changes can be analyzed.

2. Procedures: Suspended-sediment samples will be collected and analyzed using standard USGS methods at the following streamflow monitoring site:

   Tongue River below Brandenberg Bridge near Ashland

3. Report Products: Basic records will be submitted to BLM annually or as mutually agreed upon. Records will be published by the USGS in an annual basic data report, "Water Resources Data for Montana."

4. Relationship to Other USGS Studies: This program will supplement and be correlated with other USGS sediment data collection programs. The USGS operates sediment stations at the following sites:

   Yellowstone River at Billings
   Yellowstone River at Forsyth
   Tongue River below Brandenberg Bridge near Ashland
   Tongue River at Miles City
   Powder River near Locate
   Yellowstone River near Sidney

5. Distribution of Funds:

Salaries	$3,700
Travel	2,200
Laboratory Services	2,100
Data Processing	500
Total:	$8,500

C. Ground-Water Monitoring

1. Location: Fort Union coal region of eastern Montana.

2. Objectives: To provide ground-water data base from which an assessment can be made of the resource, future responses to stresses can be predicted, and pollution and supply problems can be detected and defined. This activity provides for long-term collection of ground-water data from selected observation wells. Specifically, wells monitored in EMRIA study sites are incorporated in this program to extend periods of data collection. In addition, selected holes drilled by industry or other agencies are cased and tested.

3. Procedures

a. Make water-level measurements and continue operation of water-level recorders.

b. Compile and analyze data.

c. Collect ground-water samples from selected wells.

d. Analyze water samples.

e. Case and test selected exploration holes drilled by industry or other agencies.

4. Report Products: Data collected under this program will be incorporated in EMRIA Site Study reports and in regional evaluations. The data will be stored in automated data files for rapid retrieval.

5. Relationship to Other USGS Studies: Data collected under this activity will be used to help define pre-mining conditions of reclamation study sites, help calibrate ground-water models to predict the effects of mining, and help transfer data to surrounding areas from intensively studied reclamation sites.

6. Distribution of Funds:

Salaries for Data Collection	$16,740
Laboratory Services	1,100
Travel	6,700
Data Processing	5,300
Casing	6,260
Total:	$36,100

II. EMRIA Site Studies

A. Locations: During FY 81, hydrologic studies begun in Cook, West Otter, Sweeney-Snider, and Corral Creeks will be continued. Studies will begin in Horse-Bear, Beaver, Miller-Greenleaf and Timber Creeks. Preliminary analysis of new study sites will be conducted to determine data needs at Burns, Sand, and Fox Creeks, and other mutually agreed-upon sites.

B. Objectives: To collect and evaluate hydrologic data at potential coal-lease area sites for activity planning in the Powder River and Fort Union coal regions. The studies are designed to compile available hydrologic information, design and implement site-specific data collection programs, coordinate data collection activities with other agencies and private companies, and evaluate the potential hydrologic impacts of mining and reclamation.

C. Procedures: Available hydrologic data will be compiled and evaluated. Data collection networks will be designed and implemented to acquire information. Where data are lacking, test drilling programs will be outlined to obtain the needed information. In the Otter Creek site, a test study to evaluate the effects of mining on alluvial valley floors will be implemented.

D. Report Products: A report summarizing the hydrologic data and presenting the interpretations of hydrologic conditions in each site will be prepared. In most cases, a USGS Water Resources Investigation Report would be the intended publication media, but BLM-EMRIA reports may be used as the publication release.

E. Distribution of Funds:

Salaries:	
Data Collection	$101,300
Data Analysis	63,800
Travel	38,900
Computer	13,900
Laboratory	33,400
Equipment	5,600
Total:	$256,900

III. Salinity Modeling of Tongue River

A. Location: Tongue River below Tongue River Dam.

B. Objectives: To construct and calibrate a digital model of the Tongue River which will simulate the salinity of the river through and downstream from existing and proposed mines. The model would be useful in simulating salinity in the river under various conditions of flow and development. This model would provide a tool for evaluating cumulative, off-site effects of various mine operations.

C. Procedures: A salinity model has been selected for use on the Tongue River. Data collection will be designed and implemented to obtain the necessary input information. Ground-water quality conditions, tributary quantity and quality, evapotranspiration, irrigation diversion, and return flow will be used to calibrate the model and simulate flow and quality in the river. When the model has been calibrated, various development scenarios will be simulated.

D. Report Products: A final report, summarizing the investigation findings, will be prepared for release in the USGS Water Resources Investigations series, will outline the modeling techniques used, and will present the simulation runs performed.

E. Relationship to Other USGS Studies: This program will bring together the results of several previous and ongoing studies, including runoff monitoring, surface-water-quality monitoring, ground-water-surface water interrelation studies, and runoff modeling activities.

F. Distribution of Funds:

Salaries:	
Data Collection	$ 7,500
Data Analysis	23,400
Travel	1,000
Computer	3,000
Total:	$34,900

IV. Network Analysis

A. Location: Fort Union coal region in eastern Montana.

B. Objectives: Numerous water-quality stations have been operated throughout the Fort Union coal region to obtain basic data needed to evaluate the impacts of mining and the potential for reclamation. Analysis of the data is needed to define geochemical processes, determine relationships, and evaluate the necessity of modifying the network. Studies to determine sediment transport characteristics are also needed.

C. Procedures: Statistical methods will be used to evaluate the surface-water quality data. Regression techniques will be applied to determine station correlations. Data collected from existing stations will be evaluated to determine the desirability of continuing, modifying, eliminating, or replacing stations to insure that monitoring sites provide the necessary information. Regional analysis and modeling techniques will be applied to define cause-effect relationships between water-quality and basin characteristics.

D. Report Products: The results of this investigation will be used to modify the existing surface-water-quality monitoring network in the Fort Union coal region. Several reports summarizing the statistical correlations and regression analyses have been published in the Water Resources Investigations series. Work is underway on other reports summarizing new results of correlations and sediment transports.

E. Relationship to Other USGS Studies: This activity extends the surface-water quality monitoring program to include reduction, analysis, and interpretation of data. In raw form, data from the monitoring program is of limited usefulness. By reducing the data to an easily understood form, analysis and interpretation is possible. Thus, this project greatly increases the usefulness of data collected under other programs. Results of this activity ensures collection of meaningful information. Coal Hydrology Funds from the USGS will supplement this project with $23,600.

F. Distribution of Funds:

Salaries	$15,100
Computer Costs	2,200
Total:	$17,300

V. Channel Geometry Investigations

A. Location: Fort Union coal region.

B. Objectives: To develop channel geometry equations which relate streamflow characteristics to channel features in the prairie environment of eastern Montana.

C. Procedures: Various channel features including width, depth, slope, and particle-size distribution of bed and bank material have been measured at selected sites where streamflow data is available. Regression equations relating channel geometry measurements to streamflow will be developed and evaluated. The transferability of the developed equations will be tested using short-term stream gaging sites at selected locations. The information collected in Montana will be supplied to researchers in the Central Region for use in developing regional channel geometry equations.

D. Report Products: In addition to providing the information to regional staff, the District is preparing a report summarizing the findings of the study, which will be released in FY 81. The report will contain an explanation of the principles involved, instructions on field measurement techniques, a presentation of the regression equations developed, and an analysis of the accuracy of the technique.

E. Relationship to Other USGS Studies: This study is closely coordinated with and supplements the regional research project on channel geometry under R. E. Hedman. Much of the data acquired as part of the District program will be used by Hedman in developing regional channel geometry equations. Funding for this project will be supplemented with $11,300 from the USGS Coal Hydrology Program.

F. Distribution of Funds:

Salaries:	
Data Collection	$ 1,200
Data Analysis	9,900
Travel	400
Computer Costs	1,500
Total:	$13,000

VI. Surface-Water Flow Analysis

A. Location: Fort Union coal region.

B. Objectives: To develop techniques for estimating streamflow characteristics at ungaged sites in eastern Montana. To conduct studies in selected high priority coal lease sites to estimate runoff, peak flows, and flood boundaries.

C. Procedures: Numerous techniques have been suggested for estimating various streamflow characteristics at ungaged sites. An attempt will be made to define mean annual runoff, peak flows, and recurrence intervals for selected sites throughout the coal area of eastern Montana. At some sites, flood boundaries must be defined relative to strip mine operations. This project provides funding to develop the streamflow characteristics at ungaged sites and to define flood boundaries at selected high priority coal lease sites. Best available techniques will be used which could include regional equations, channel geometry techniques, crest-stage gage information, and regional runoff maps or rainfall-runoff models. Available information, local topography, geologic conditions, proximity to long-term gaging stations, and similar factors will be considered in selecting the most applicable methods to be used.

D. Report Products: In general, the results of this study will be included as parts of EMRIA site studies. For some areas, flood prone area maps may be prepared for open-file release. No final report is anticipated, but state-of-the-art technical papers may be prepared for publication in journals.

E. Relationship to Other USGS Studies: This project is closely related to stream gaging networks including benchmark stations, short-term monitoring stations, miscellaneous sites, and crest-stage gages. The results of channel geometry work and the rainfall-runoff modeling projects will be used in estimating runoff at ungaged sites. The USGS coal hydrology program will supplement this project with about $15,600.

F. Distribution of Funds:

Salaries:	
Data Collection	$16,300
Data Analysis	16,400
Travel	3,300
Computer	1,500
Total:	$37,500

VII. Hydrologic Modeling

A. Location: Prairie Dog Creek watershed in southeastern Rosebud County has been selected as the study site.

B. Objectives: The USGS has developed rainfall-runoff models which accurately predict runoff from storm events in some environments. However, the models have been developed for use in geologic and climatic conditions quite different from the prairie environment of Montana's coal region. The USGS is attempting to modify existing models to be responsive to the climatic and geologic conditions which prevail in eastern Montana. The Montana District, in conjunction with other WRD districts and Regional research hydrologists, will pursue problems related to runoff from snowmelt and for rainfall on frozen ground and other situations more appropriate to the northern plains region. Hopefully, the modified model can be calibrated for the Prairie Dog Creek watershed to verify its suitability for this area. If successful, the model will be extremely useful in evaluating the effects of land-use changes such as strip mining or reclamation on run-off from small drainages.

C. Procedures: The Prairie Dog Creek watershed has been instrumented with climatological and soil-moisture monitoring equipment to determine various parameters for modeling. Precipitation gages have been installed, soil-moisture access tubes have been emplaced, soil-temperature probes have been planted, stream gaging stations have been constructed, and monitoring of various parameters has begun. Data are being processed and modeling has begun.

D. Report Products: Data collected as part of this study will be extremely valuable to researchers in other agencies and to universities. To make this data useful to others, a series of basic data reports is planned to release climatological, soil, and streamflow data. Progress reports describing activities and work accomplished are planned for open-file release. A final report describing the research and results is planned in cooperation with other WRD districts. The final report will probably be published in the Professional Paper series to allow wide distribution.

E. Relationship to Other USGS Studies: This project complements other programs in the Montana District. One currently troublesome aspect of rainfall-runoff modeling, for example, is the relationship of streamflow to ground-water systems. Work on the ground-water aspects of the study area being funded under another project will be extremely useful in evaluating the relationship of infiltration and ground-water discharge to streamflow. Several other WRD districts are involved in modifying existing runoff models to simulate various climatic, geographic, and geologic settings. Montana's work will be closely coordinated with these districts to minimize duplication, exchange information, and share experience and equipment.

D. Distribution of Funds:

Salaries	$26,600
Travel	15,500
Computer Costs	11,800
Laboratory	2,400
Equipment	2,400
Total:	$58,700

VIII. Grant to Montana Bureau of Mines and Geology for Test Drilling and Aquifer Testing in High Priority Lease Areas and Investigations of the Soluble Salts in Coal Overburden and the Qualities of Ground Waters in Spoils

A. Location: Fort Union coal region near Ashland, West Otter, Corral, Sweeney-Snyder, Horse-Bear, Timber, and Beaver Creeks coal lease area.

B. Objectives: To drill test holes, install casing, conduct aquifer tests, and monitor water levels at selected sites in high priority lease areas. This grant provides for collecting ground-water data in areas where data are needed to evaluate effects of mining and potential for reclamation. The objective of the soluble salts study is to develop techniques for predicting probable ground-water quality resulting from surface mining of coal.

C. Procedures: After initially evaluating existing data, locations where additional information is needed will be selected. The Montana Bureau of Mines and Geology will drill test holes at the selected sites, install casing, conduct aquifer tests, collect water samples, and monitor water levels. Additional research wells will be installed in spoils at the Decker, Rosebud, and Big Sky mines. Following installation, the wells will be tested by pumping to determine hydraulic conductivity values and to obtain samples for quality analysis. Selected wells will be equipped with

continuous water-level recorders. Some will be re-tested periodically to determine transmissivity and water-quality changes that occur due to changes in saturated thickness. Compaction due to saturation occurs continuously in the spoils and will be examined periodically through use of refraction-seismograph techniques to determine effects on spoil transmissivity and water quality at selected research wells.

Overburden and spoils samples will be collected by coring and grab-sampling and will be submitted for laboratory leaching and paste-extract analyses.

Water-level and water-quality data will be added to the computer file for statistical and trend analyses. Determination of salts available for dissolution from overburden materials will be made from chemical analyses of water-saturated-paste extracts of core samples. In addition to the suite of cations routinely run in these analyses, determinations of sulfate concentrations will be made; chloride can be assumed insignificant, so bicarbonate content will be estimated by subtraction. Column-leach tests will be conducted on some of the materials, and chemical analyses of the leachates will be used to validate the extract chemistry. For the saturated pastes and leach tests, both distilled water and site-collected ground and surface waters will be used. During the leach tests, leachate quality will be carefully monitored to define rates of salt removal. Type curves will be generated for dissolution rates to characterize hypothetical rates of salt removal from mine spoils.

D. Report Products: Field data will be compiled in a report describing the results of drilling and testing. Montana Bureau of Mines and Geology will submit the report to USGS for distribution to BLM. Annual progress reports for the soluble salts study will describe activities and results after each of the first 2 years. At the end of the third year, a final report will summarize the research and will include a recommended technique for predicting spoil-water quality. Additional communications during the project period will probably also be necessary to provide input to off-site transport models being developed by other researchers.

E. Relationship to Other USGS Studies: The grant provides basic geologic and hydrologic data needed for completion of EMRIA site studies. Without the information from this program, definition of the ground-water systems would be difficult.

F. Distribution of Funds:

Grant to Montana Bureau of Mines and Geology	$187,400

IX. Willow Creek Basin, Flood Routing Model (MT-930-4340-5225)

A. Location: Willow Creek Basin, Valley County, Montana

B. Objectives: To collect hydrologic information including precipitation, runoff, and basin characteristics needed to construct and calibrate a flood routing model of the Lone Tree Creek and Wilderness Coulee basins. Purpose of the modeling effort is to evaluate the effectiveness of flood-control facilities which currently exist in the basins and assess the need for modification or expansion of flood-control structures. Demonstrate the transfer value of the model to other small watersheds within the Willow Creek Basin.

C. Procedures: Existing flood-control structures in the Lone Tree Creek watershed include approximately 40 small reservoirs. The Wilderness Coulee basin includes five reservoirs and a water-spreading facility. All structures will be surveyed by BLM crews to determine the hydraulic characteristics. The surveys will define capacity-elevation relationships as well as stage-outflow relationships.

Two reservoir-stage gages and two stream-gaging stations will be installed and operated to determine basin runoff and efficiency of water-spreading facilities in the Wilderness Coulee basin. One reservoir-stage gage will be installed on TC reservoir in the Lone Tree Creek basin. Five recording rain gages will be installed at selected locations in the two basins to monitor distribution and rate of precipitation events. Several volumetric rain gages will be installed throughout the basins to obtain information on areal distribution of summer thunderstorms.

After sufficient hydrologic information has been collected, the data will be used to construct and calibrate models of the watershed. Various existing models including the Corps of Engineers' HEC1, SCS's STR-20, and SEA's HYMO models will be tested. The most appropriate model will be used to simulate runoff under various development scenarios to evaluate the effectiveness of alternative management plans.

D. Report Products: Progress reports summarizing the data-collection program will be prepared at the end of each year's effort. A final report describing the model development phase will be prepared at the end of FY 83 and will be released in the USGS Water Resources Investigations series.

E. Relationship to Other USGS Studies: This project will not duplicate other programs of the USGS. Knowledge of runoff-basin characteristics gained through the Stream Response Modeling Efforts at Prairie Dog Creek will be useful in developing models in Willow Creek Basin.

F. Distribution of Funds:

Stream Gages	
Installation	$8,000
Maintenance	7,500
Precipitation	
Installation	2,500
Maintenance	500
Total:	$18,500

X. Reservoir Limnology (MT-930-4340-5225)

A. Location: Phillips and Valley Counties resource areas.

Reservoir Name	Location	County
Air Base Pond	T. 31 N., R. 39 E., Sec. 13	Valley
Gary Reservoir	T. 33 N., R. 37 E., Sec. 2	Valley
King Reservoir	T. 24 N., R. 30 E., Sec. 15	Phillips
Empire Reservoir	T. 28 N., R. 29 E., Sec. 22	Phillips

B. Objectives

1. To describe the seasonal changes in the physical, chemical, and biological quality of small reservoirs in northeastern Montana to determine whether different management uses, such as fish propagation and water fowl production, might be more effective if employed at different times during the life of a reservoir.

2. To provide a basis for evaluating grazing management practices around the reservoirs.

C. Procedures: Four of the 24 reservoirs studied in water years 1978-1979 will be sampled six times during the 1981 water year at a frequency of approximately every six weeks beginning in late winter and ending in early fall. The four reservoirs have limnological conditions that indicate possible management for fish propagation and water fowl production. The different construction dates, specific conductance levels, water types, and nutrient levels of the four reservoirs suggest that the resulting data could provide information of high transfer value.

During each sampling period, depth profiles will be made of temperature, dissolved oxygen, specific conductance, and pH. Depth profiles of percent remaining light will be made during sampling periods of no ice cover.

Water samples for chemical and biological analyses will be collected near the surface and near the bottom of each reservoir during each sampling trip. Chemical analyses will include (1) major dissolved constituents--calcium, magnesium, potassium, sodium, alkalinity, chloride, fluoride, sulfate, and silica; (2) trace elements--copper, manganese, iron, and lead; and (3) nutrients--nitrite plus nitrate dissolved, nitrite plus nitrate total, ammonia total, organic nitrogen plus ammonia total, ortho phosphate dissolved, phosphorus total, and organic carbon total. Biological analyses will include species identification of phytoplankton and zooplankton. Phytoplankton samples will be supplemented at times with chlorophyll a analyses. Benthic invertebrate samples will be collected in late spring and late summer and will be analyzed for species identification.

Diel profiles of temperature, dissolved oxygen, specific conductance, and pH will be made at each reservoir during the later summer sampling period. Water samples for chemical and biological analyses will be collected in the early morning, late afternoon, early night, and late night to supplement these profiles.

Fecal coliform and fecal streptococcal bacteria will be collected from grab-samples of water at each chemical sampling site and near the shore of easiest access to each reservoir.

D. Report Products: A final report covering the reservoir sampling described herein will be available for review in middle FY 82 and in final form before the end of FY 82.

E. Relationship to Other USGS Studies: This project is a continuation of reconnaissance-level surveys of lakes and reservoirs performed under earlier BLM-funded projects.

F. Distribution of Funds:

Salary:	
Data Collection and Analysis	$ 9,300
Travel	3,600
Lab Charges	7,400
Contractural Services	9,200
Computer Services	500
Total:	$30,000

Nevada

NEVADA

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

Project	EMRIA	Other (4340)
Flood Hazard Evaluation	---	$60,000

TOTAL for Nevada: $60,000

NEVADA WORK PLAN OUTLINE
USGS WATER RESOURCES DIVISION

I. Flood Hazard Evaluation (NV-930-4340-5225)

A. Location: Great Basin Region, Nevada

B. Introduction: The BLM is inventorying the natural resources of that part of the public land that they administer. This inventory is in response to a directive from the U.S. Congress. As part of the inventory, the BLM plans to delineate areas having flood-related hazards. They have asked the USGS for assistance with Methodology for the delineation of flood-hazard areas in the Great Basin.

C. Objectives

1. Appraise the merits of the different methods for their possible uses in delineating flood-hazard areas in BLM lands in the Great Basin.

2. Make recommendation on which methods are preferred in delineating flood-hazard areas in mountains, in alluvial fans and valleys, and in playas.

3. Present guidelines, mainly by samples, on the use of the different suggested methods.

D. Approach: The study plan for the proposed project consists of two parts--(1) an overview of flood-related hazards and analytical procedures, and (2) technical procedures and approaches, summary, and recommendations.

Priority tasks for Part 1 are:

1. Describe the scope of problems as to: hydrologic and hydraulic setting, geographic limits, political subdivisions, geomorphic regimes, (mountains, alluvial fans and valleys, and playas).

2. Compile reports and data.

3. Review published data and reports on flood hydrology and related subjects. Compile bibliography.

4. Schedule meeting with "flood specialists" and others in Western States to discuss the problem and explore approaches.

5. Prepare report summarizing Part 1.

The study may be terminated or significantly altered after Part 1 if the results of the overview indicate that the state-of-the-art will not allow for the development of adequate technical procedures and approaches.

Priority tasks for Part 2 are:

1. Describe procedures that are recommended for mountainous areas, which will include discussions concerned with flood-frequency analyses, procedures for determining flood-carrying capacities of channels, methods used to determine water-surface profiles, and depth and velocity aspects of the problem.

2. Describe procedures that are recommended for predominantly alluvial-fan areas. Included will be discussions concerned with flood-frequency analyses, procedures for determining: attenuation away from mountainous areas, flood-carrying capacity of streams, water-surface profiles, space variability of flows, and depth and velocity aspects of the study.

3. Describe procedures that are recommended for playa areas, which will include discussions concerned with flood-frequency analyses and playa volume-stage relations.

4. Describe assumptions, limitations, and uncertainities for the different recommended methodolgies.

5. Present technical techniques to "flood specialist." Incorporate appropriate feedback to technical procedure.

6. Discuss recommended techniques with BLM personnel.

E. Reports and Due Dates: Part 1 Status Report is due September 30, 1981.

F. Distribution of Funds:

Salaries	$47,370
Vehicle	1,580
Travel	7,890
Computer	3,160
Total:	$60,000

II. Saval Hydrology Studies (YA-450-PP1-22)

A. Location: Saval Research and Evaluation Project, Elko County, Nevada

B. Objective: Hydrologic and water quality baseline determination for Gance Creek at State Highway 51 and Mahala Creek at State Highway 51.

C. Procedures:

1. Data Collection:

   a. Daily discharges
   b. Peak discharges
   c. Water temperature (periodic)
   d. Dissolved oxygen (periodic)
   e. pH (periodic)
   f. Specific conductance (periodic)
   g. Total sediment
   h. Low flow

2. Data Reduction/Analysis: USGS District Office routine procedures.

3. Data Reporting: Basic water data reporting for Nevada, WRD.

D. Relationship to Other Studies: The resulting data will be used for calibration of the USGS rainfall-runoff model, under development with a separate Central Region EMRIA research project, p. 102 of this workplan.

E. Distribution of Funds: (Non-EMRIA)

Operation and Maintenance	$8,400
Sediment (4 Stations)	900
Total:	$9,300

New Mexico

NEW MEXICO

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA
Watershed Characterization	$ 20,000
Hydrologic Surveillance	120,300
Hydrologic Modeling-Kimbeto	70,450
Total:	$210,750

USGS WATER RESOURCES DIVISION
WORK PLAN OUTLINE
NEW MEXICO - EMRIA WORK PLAN PROPOSAL FOR FY 1981

I. Watershed Characterization

A. Location: Coal-lease areas in San Juan, Sandoval, and McKinley Counties located in northwestern New Mexico.

B. Introduction: The BLM need methods to estimate quantity and quality of runoff from small ungaged drainage areas to evaluate water resources in planning studies.

C. Objectives: To provide BLM with a method to estimate quantity and quality of runoff from small ungaged drainage areas in northwestern New Mexico.

D. Approach: The data to develop relationships to estimate streamflow and water-quality characteristics from watershed parameters in the coal-lease areas is continually being compiled and analyzed. The data being collected for gaged small watersheds, most of which have short periods of streamflow and water-quality records, include channel-geometry measurements, streambed material particle-size distribution, channel slope, infiltration rate of watershed and vegetative cover. Other data being compiled for each of the watersheds include drainage area, mean-annual precipitation, watershed slope, and basin shape. Regression techniques are used to develop methods for predicting streamflow and water-quality characteristics from channel geometry and watershed characteristics.

E. Report Products and Due Dates: A report defining parameters for estimating selected streamflow characteristics will be completed in September 1981, which will include more parameters than the 1980 report.

F. Relationship to other Studies: This study will be closely coordinated with a regional watershed characterization study of strippable coal areas in the central and western United States. The objectives of the regional study are: (1) to test the transferability of existing streamflow-basin characteristic relationships to coal-lease areas; (2) to develop new relationships for streamflow characteristics to measurable dimensions of channel geometry and basin characteristics for ephemeral streams; and (3) to develop similar relationships for estimating sediment transport characteristics and other water-quality transport characteristics for perennial and ephemeral streams.

G. Progress: A report titled, "Drainage Area, Active-Channel Width, and Soils as Related to Ephemeral Streamflow Characteristics in Northwestern New Mexico," has been submitted for approval as an Open File Release (May 1980).

H. Distribution of Funds:

Salaries	$17,160
Laboratory Services	980
Travel	1,260
Data Processing	600
Total:	$20,000

II. Hydrologic Surveillance of Coal-Lease Areas

A. Location: Coal-lease areas of San Juan and McKinley Counties located in northwestern New Mexico.

Streamflow (Continuous Record) and Water-Quality Sites

Shumway Arroyo near Fruitland
(Sec. 22, T. 30 N., R. 15 W.)

Shumway Arroyo near Waterflow
(Sec. 32, T. 30 N., R. 13 W.)

De-na-zin Wash near Bisti Trading Post
(Sec. 14, T. 23 N., R. 13 W.)

Hunter Wash at Bisti Trading Post
(Sec. 13, T. 23 N., R. 13 W.)

Surface-Runoff (Partial Record) Water-Quality Sites

Alamo Wash near Tanner Lake
(Sec. 13, T. 23 N., R. 13 W.)

Coal Creek above Tanner Lake
(Sec. 17, T. 23 N., R. 12 W.)

De-na-zin Wash above Tanner Lake
(Sec. 9, T. 23 N., R. 12 W.)

Hunter Wash Tributary near Bisti Trading Post
(Sec. 5, T. 23 N., R. 13 W.)

Tsosie Swale near Kimbeto
(Sec. 5, T. 22 N., R. 11 W.)

Ground-water Observation and Water-Quality Sites

Bisti West EMRIA Study Site
(7 wells (T. 23 N., R. 12 W.)

Kimbeto EMRIA Study Site
(10 wells (T. 22 N., R. 9-10 W.)

Ojo Encino EMRIA Study Site
(5 wells (T. 19-20 N., R. 5 W.)

B. Prior to 1975, virtually no water resources information was available in the coal-lease areas in northwestern New Mexico. The EMRIA program began in New Mexico in FY 1975 to assure adequate baseline water resources data would be available for choosing reclamation goals and establishing lease stipulations for surface mining for coal.

C. Objectives: To (1) document hydrologic characteristics of streamflow and ground water in coal-lease areas and their variabilities in quantity and quality and (2) predict the effects of coal extraction and associated development on the water resources in northwestern New Mexico. This information will aid BLM in their operations pertaining to coal-lease stipulations and land management practices of multiple purpose uses of the public domain.

D. Approach: The established basic data collection sites will be continued to collect adequate water resources data under natural or present conditions to establish a baseline as to quantity and quality from which to predict the effects of surface extraction of coal and related activities. Some of the areas at or near the gaged sites will be mined in the future which will enable us to compare the measured effects of surface mining for coal on the water resources to the predicted effects.

The four established continuous record streamflow data collection sites each have a set of three to four single-stage samplers for collecting water-quality samples at low, medium, high and flood stages. One of the sites is also equipped with an automatic pump sampler. The five (5) established partial-record, surface-runoff sites for collection of water samples inflowing into study areas from the main arroyos or side washes are equipped with single-stage samplers.

We will continue to collect and analyze for comprehensive suite of water-quality parameters at least semiannually at ephemeral and perennial streams. The comprehensive suite of parameters will include major inorganic constituents, trace elements, nutrients including organic carbon, radio-chemical parameters (annually), and suspended sediment data. Water samples will be collected and analyzed for major constituents monthly at perennial streams and quarterly at ephemeral streams.

Water-quality parameters such as specific conductance, pH, suspended-sediment concentration and organic carbon will be measured on additional samples because of their usefulness as index water-quality parameters. Other constituents found in unusually high concentrations will also be analyzed more frequently. We will attempt to analyze a minimum of six samples for partial chemical analyses from each site annually and to sample as many flow events as possible at a site. Samples will be collected by field personnel if the site is found flowing, by single-stage samplers, or by automatic pump samplers (see Attachment A).

The 22 established ground-water data collections sites are completed either in the overburden, in the coal seams, or in the Pictured Cliffs sandstone underlying the coal seam. We will measure water levels semiannually and collect water samples from about one-half of these wells for complete chemical analyses (see Attachment B). After collection of sufficient samples over several years to define the water quality in these wells, the sampling frequency will be reduced if no water-quality changes are found in that well.

E. Report Products: All data collected in the BLM-EMIRA program will be published by the USGS in the annual basic data report, "Water Resources Data for New Mexico." Water resources information that have been collected in the BLM-EMRIA program and other programs in the strippable coal areas will be analyzed to aid BLM in management decisions of coal-lease areas of the public domain in the interim prior to the release of comprehensive formal reports such as water-supply papers. Preliminary information on transfer techniques and interpretations of flow systems will be the subject of these studies. The subjects of these studies will be determined through close collaboration with BLM personnel. Proposed reports are:

1. Water-quality characteristics of surface-water resources in strippable coal areas in northwestern New Mexico, September 1981.

2. Characteristics and chemical quality of shallow water-bearing units in the strippable coal areas in northwestern New Mexico, September 1981.

Relationship to Other Studies: The hydrologic surveillance effort is coordinated with 15 streamflow gaging sites, 25 surface-water quality sites, 15 observation-well sites (water level and water quality) supported with Federal coal hydrology funding and four streamflow and water-quality sites funded by the National Park Service. Most of the sites were established October 1977. Interpretation of hydrology and techniques to transfer data to ungaged drainage basin in coal-lease areas of northwestern New Mexico for BLM-EMRIA reports will make use of all data available from all projects in the project area.

G. Distribution of Funds:

Salaries	$43,600
Laboratory Services	26,000
Travel	8,500
Equipment and Supplies	14,400
Operation and Maintenance of Existing Gages	24,200
Data Processing	3,600
Total:	$120,300

III. Hydrologic Modeling-Kimbeto EMRIA Study Site

A. Location: The modeling control basin with drainage area of 8.2 mi is located within BLM's Kimbeto reclamation study area in northwestern New Mexico.

B. Introduction: Initially (1975) the EMRIA program was directed to obtaining baseline water-resources information. In 1977, Congress passed the Surface Mining Control and Reclamation Act (Public Law 95-87). This act specifically addressed hydrologic impacts of surface mining, i.e., the mine plan would have to show how the hydrologic balance of the mine area would be restored to premine conditions before a plan could be approved. The Federal land manager must be certain reclamation criteria goals can be met. A drainage basin was instrumented in 1978 to collect data for the development of a predictive precipitation-runoff model.

C. Objectives: The objectives are to develop, calibrate, and verify precipitation-runoff models for predicting surface runoff characteristics and sediment yield under various land use conditions in the coal-lease areas in northwestern New Mexico. The emphasis will be on relating parameters used by the model to measurable physical features of a selected watershed basin to facilitate transferability of the model from an instrumented basin to uninstrumented basins.

D. Approach: A watershed (Ah-shi-sle-pah Wash) with a drainage area of 8.2 mi in the strippable coal-lease area in the San Juan Basin is instrumented to collect data for the development, testing, calibration, and verification of precipitation-runoff models. The instrumentation includes a streamflow gaging station, an automatic pump sampler, single-stage samplers, 12 moisture observation wells, meteorological station, and five recording raingages located for equal area distribution over the basin (T. 22 N., R. 10 W.). Collection of water-quality data from reclaimed spoil piles at three sites at the San Juan mine (T. 30 N., R. 15 W.) and three sites at the Navajo mine (T. 29 N., R. 15 W.) will be continued.

Data collection and analyses for model development will be continued to define basin soil properties, soil-water storage characteristics, soil detachability, vegetation characteristics, and topography. Data will be tested in the basic model developed by the Regional Precipitation-Runoff Modeling Project as it is being collected. Data testing during the collection period will aid in refinement of data collection techniques.

E. Reports Products: An interim report will be prepared in about 1981, when enough data will be available for an initial calibration of the model, as additional data are collected and the model is improved and verified.

F. Relationship to Other Studies: This program is closely coordinated with the Regional Precipitation-Runoff Modeling Group in Denver, Colorado. The modeling group in Denver is developing a basic model to be used in coal-lease areas.

G. Distribution of Funds:

Salaries	$52,700
Laboratory Services	3,200
Travel	4,950
Equipment and Supplies	4,000
Operation and Maintenance of Existing Gages	2,200
Data Processing	3,400
Total:	$70,450

Attachment A.
Sampling Frequency and Water-Quality Parameters
for Surface-Water Stations.

Frequency	Schedule Name	Parameters	Phase
Monthly for perennial sites; four per year for ephemeral sites	Major constituents, add boron	Ca, Mg, Na, K, Cl, F, SiO_2, SO_4 alkalinity, ROE, & B	Dissolved
"	Nitrogen & phosphorous compounds	N & P compounds	Dissolved and total
"	Organic carbon	Organic carbon	Dissolved and total
"	Iron, manganese	Fe & Mn	Dissolved and total
"	Suspended sediment	Suspended sediment concentration and percent finer than 62.5 microns	Suspended
Four to eight flow events captured by sets of single stage samplers positioned at low, medium, high, and flood stages at each ephemeral site	Single stage samples	HCO_3. CO_3, pH, Fe, Mn, TOC and suspended sediment including percent finer than 62.5 microns	Total (sample captured by single stage samplers)
Semiannually for perennial sites and for ephemeral sites	Drinking water toxic trace elements and trace elements associated with coal (by atomic absorption)	As, Ba, Cd, Cr, Pb, Hg, Se, Li, & Sr	Dissolved and total
"	Suspended sediment	Particle size distribution	Suspended
Annual at perennial and ephemeral sites	Emission spectrographic semiquantitative scan of trace metals	Al, Sb, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Ga, Ge, Fe, Pb, Li, Mg, Mn, Mo, Ni, K, Si, Ag, Na, Sr, Sn, Ti, V, Zn, & Zr	Dissolved

Attachment A. (Cont'd.)

Frequency	Schedule Name	Parameters	Phase
Annual at perennial and ephemeral sites	Radiochemical	Gross alpha, gross beta, uranium, & radium	Dissolved and suspended
"	Bottom material trace metals	As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, & Zn	Bottom material
"	Bottom material nutrients	Organic N, NH_4, NO_2+NO_3, & P	Bottom material
"	Bottom material	Particle size distribution	Bottom material

Attachment B.
Sampling Frequency and Water-Quality Parameters
for Ground-Water Sites

Frequency	Schedule Name	Parameters	Phase
Annual at selected well sites	Major constituents, add boron	Ca, Mg, Na, K, Cl, F, SiO_2, SO_4, alkalinity, ROE, & B	Dissolved
"	Nitrogen and phosphorous	NO_2, NO_3, NH_4, organic N, P & PO_4	Dissolved
"	Organic and inorganic carbon	DOC, DIC	Dissolved
"	Dissolved sulfide	S^{-2}	Dissolved
"	Trace metals (by atomic absorption)	As, Ba, Cd, Cr, Pb, Hg, Se, Li, Sr, Fe, & Mn	Dissolved
"	Trace metals by emission spectrographic scan	Al, Sb, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Ga, Ge, Fe, Pb, Li, Mg, Mn, Mo, Ni, K, Si, Ag, Na, Sr, Sn, Ti, V, Zn, & Zr	Dissolved
"	Radiochemical	Gross alpha, gross beta, U, & Ra	Dissolved

North Dakota

NORTH DAKOTA

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

Site-Specific Hydrologic Investigations	
Wibaux-Beach Deposit	$21,800
Rattlesnake Butte Area, Dickinson Deposit	70,660
SE Williams County Deposit	150,000
New Leipzig Deposit, preliminary analysis of data	25,000
McKenzie County Ground-Water Reconnaissance Study	7,480
Fort Union Coal Region Geochemistry (EPA Contribution 100,000)	24,000
Hydrologic Modeling, Fort Union Coal Region; Beach-Wibaux and Antelope Creek	157,890
Hydrologic Monitoring--Surface-Water Stations (2); Observation Wells; 16-Beach Wibaux, 6-Antelope CR; Flood Plain Delineations	14,600
Airborne Snow Surveys	25,100
Total:	$496,530

NORTH DAKOTA

I. Site Specific Hydrologic Investigations

A. Wibaux-Beach Deposit

1. Objectives: The strippable lignite of the Wibaux-Beach deposit is a major aquifer of the area and is in close stratigraphic association with the other aquifers. The deposit area is probably within a region of major recharge to the lower Tongue River and Ludlow aquifers. The probable hydrologic impacts of coal development on these aquifers are not known. Most streams within the study area are ephemeral, but one does flow for most of the year and is the irrigation water source for several adjacent landowners. Mining activities may impact the surface waters in terms of both quantity and quality of streamflow. Also of concern are the geochemical modifications attendant to the mining process and the effects these alterations may impose on the hydrologic system.

The objectives of this investigation are to: (1) define the pre-mining hydrology and geochemical regime within the drainage basins containing the Wibaux-Beach lignite deposit. A historical data base will thus be established to assess any modifications attendant on future coal mining; and (2) develop the capability of projecting the hydrologic ramifications of various land treatments imposed by the mining process.

2. Approach: Strip mining disrupts the zone of interaction between the atmospheric, terrestrial, and subterranean segments of the hydrologic cycle. Programs and instrumentation necessary to determine the flow and quality characteristics and the various modes of exchange of water between the respective segments will be initiated early in the project. The collected data will be used in conjunction with digital models to gain a thorough knowledge of the hydrologic regime. Quantitative hydrologic parameters will be refined and data deficiencies will be identified with the aid of the models. When the models are calibrated and verified against the present hydrologic system, they will be available for estimating the hydrologic ramifications of various land treatments within the study area.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The study is funded jointly through EMRIA funds and U.S. Geological Survey Federal funds. The Wibaux-Beach lignite deposit is one of the deposits covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY 75, was scheduled for completion in FY 77, and was funded by the USGS. The portion of the deposit in Golden Valley County is covered by the County Ground-Water Resources Study under ND-069, which was started in 1975. This study was funded under a cooperative agreement by the USGS, North Dakota State Water Commission, U.S. Park Service, and U.S. Forest Service. These studies, though at a reconnaissance level, result in substantial savings in the present study. The report for ND-070F is still being processed.

   Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the study. These data are being collected through programs with the North Dakota State Water Commission, and with USGS funds. There will be a mutually beneficial exchange of data between the programs.

4. Progress Through 1980: Some 100 observation wells and four continuous-record stream-gaging stations were monitored throughout FY 80 to assess the water resources of the Wibaux-Beach lignite deposit area and to contribute to the historical record of the premining hydrologic regime of the study area. At least one full year of monthly hydrographs will be available for all the observation wells at the end of FY 80 and the stream-gaging stations will have recorded three years of discharge data. Chemical analyses have been obtained for 90 percent of the observation wells. The streams were sampled for chemical analysis at least twice annually.

   No aquifers of regional significance overlie the commercial lignite of the Wibaux-Beach deposit. The Harmon lignite bed of the lower Tongue River Member is the shallowest aquifer that occurs throughout the study area. Underlying aquifers in the lowermost Tongue River and upper Ludlow Members consist of thick sand beds but occur with far less areal consistency. Structure-contour and potentiometric-surface maps have been constructed for the aquifers. Aided by simulations with a digital computer model, interpretations of the ground-water flow system are being formulated. Numerical values for the aquifer parameters that are fundamental to the interpretation were determined largely by well-response tests.

Derivation of streamflow statistics will be possible when a few more years of discharge data are available. This extended objective will be pursued as part of a continuing surface-water modeling project.

Sufficient chemical data have been collected to characterize the chemical quality of each of the aforementioned aquifers and the streams of the study area. Maps showing the areal distribution of chemical species concentrations have been prepared. Basic interpretations of the geochemistry of the study area will be made.

The final report is in preparation and will be completed as model-aided interpretations and conclusions are drawn.

5. Distribution of Funds:

Salaries	$20,800
Data Processing, including computer costs	1,000
Total:	$21,800

6. Reports: Basic records for surface-water quantity and surface-water quality stations will be published in the USGS annual series, "Water Resources Data for North Dakota, Water Year 19__," or as an appendix to an interpretive report. Basic records for ground-water quality stations will be available to BLM and other interested parties and as an appendix to the interpretive report. The interpretive report on the hydrologic evaluation of strip mining and reclamation in the Wibaux-Beach area is scheduled for review by April 1981 and will probably be published in the Water Resources Investigation Series of the USGS.

B. Rattlesnake Butte

1. Objectives: In response to the Interior Department's recent call for leasing nominations of Federal coal lands, most eligible tracts within the Dickinson deposit were submitted by mining concerns for consideration of their leasing potential. The interest manifest in the Dickinson field indicates a possibility of future development, of which the Rattlesnake Butte area is a part. This study is an investigation to

evaluate the probable hydrologic impacts of that potential development in an area of interest to BLM. Depending on the hydraulic properties and the areal continuity of the lignite and adjacent aquifers, many of these water sources could be diminished or obliterated.

Of particular significance to the city of Dickinson would be the effects on the Heart and Green Rivers. The Heart River is located one mile west of Dickinson and serves as the city's water supply reservoir. The Bureau of Reclamation is currently studying the feasibility of creating a water supply reservoir on the Green River, anticipating future shortage.

The primary objectives include assessing the groundwater flow system and its chemical characteristics and determining surface-water flow magnitudes and frequencies, chemical quality, and sediment concentration and load.

By defining the hydrologic regime of the study area, a further objective will be satisfied--establishing a historical data base to monitor changes in the system as mining proceeds. The ultimate objective is to develop the capability of making reasonably accurate projections of the hydrologic effects which result from the various physical treatments imposed by surface mining. Management agencies would then be able to utilize this predictive tool to augment their decision-making processes.

2. Approach: Such operational components of the total hydrologic regime as infiltration and percolation, evapotranspiration, changes in storage in the unsaturated zone, and the various modes of exchange between shallow subsurface and surface-water systems, will be quantitatively assessed. This will allow for appropriate perspective placement of each component in the overall system. One of the early project emphases will be Program implementation. Also emphasized will be effecting the instrumentation necessary to quantify all hydrologic cycle segments and pathways and to discern the nature of and the mechanisms operative on its water quality.

   Collected data will be used with digital models to gain a thorough knowledge of the hydrologic system. Quantitative hydrologic parameters will be refined and data deficiencies will be identified with the aid of the model. This refine-simulate-refine process will be

repeated until the model is calibrated and satisfactorily represents the real system. It will then be available for estimating the hydrologic effects of various land treatments within the study area.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The Dickinson deposit is one of the deposits that will be covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY 75 and is funded by the U.S. Geological Survey. The data collection under ND-070F will be of value to the present study. Since the ultimate objective of ND-070F is to provide an in-depth appraisal of the hydrologic effects of mining for each of the identified strippable deposits, the Rattlesnake Butte study will result in a savings in the eventual overall cost of ND-070F.

   Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the study vicinity. These data are being collected through programs with the North Dakota State Water Commission, Environmental Protection Agency, Corps of Engineers, and USGS funds. There will be a mutually beneficial exchange of data between the programs.

4. Progress Through 1980: The first of two drilling programs was completed in 1979. Eighteen test holes were drilled to an average depth of 400 feet. The geohydrologic environment was found to vary markedly across the study area. Observation wells were installed in aquifers where encountered. A sand section in the lower part of the Sentinel Butte Member occurs persistently across the central part of the study area and was tapped with several observation well completions. The commercial lignite bed underlies the eastern third of the study area and observation wells were installed in it where the lignite was saturated.

   Continuous-record gaging stations have been in operation on the two major streams draining the study area since fall '77 and fall '78, respectively. The streams are characterized by relatively high springtime flows derived from snowmelt, intermittent discharge peaks following summer thunderstorm activity, and sustained baseflow of very minor magnitude during the rest of the year.

All existing observation wells have been sampled for chemical analysis. Samples are taken at the gaging stations at least twice annually and at miscellaneous locations during the fall baseflow period.

Geologic and hydrologic data acquired from the first drilling program have been interpreted. Structure, thickness, and potentiometric-surface maps have been constructed for the major aquifers. Single well response tests are being conducted to determine aquifer transmissivities. If feasible, these data will be utilized in a digital flow model of the shallow ground-water system.

Additional geohydrologic data will be acquired through a second drilling program to be completed in late FY 80. The collection of monthly water-level data from all observation wells and of continuous discharge data from the two gaging stations will continue through FY 81. Final interpretations will be drawn and the report will be prepared in FY 81.

5. Distribution of Funds:

Salaries	$64,100
Travel	2,000
Laboratory Costs	1,000
Contractual Services	1,000
Data Processing, including computer costs	2,560
Total:	$70,660

6. Reports: Basic records for surface-water quantity and surface-water quality stations will be published in the USGS annual series, "Water Resources Data for North Dakota, Water Year 19__," or as an appendix to an interpretive report. Basic records for ground-water levels and ground-water quality stations will be available to BLM and other interested parties and as an appendix to the interpretive report. The interpretive report on the hydrologic evaluation of the Rattlesnake Butte area is scheduled for review by April 1981 and will probably be published in the Water Resources Investigation series of the USGS.

C. M and M Deposit, Southeast Williams County

1. Objectives: The study area consists of about 230 sq mi in southeastern Williams County. It includes five drainage basins underlain by four potential strippable lignite beds. The drainage basins are tributary to Lake Sakakawea, which forms the southern boundary of the area. The eastern boundary of the study area conforms to the eastern limit of the Dry Creek drainage basin and the northern boundary conforms to the northern limit of the Beaver Creek drainage basin. The western boundary is formed by the western limits of Beaver, Nelson, and Tobacco Garden Creek drainage basins.

   At the present time there are no mining activities in the study area, nor are any expected within the next few years. Consequently, mining impacts will not be observable during the life of this study. All hydrologic observations will be of the premining or natural condition. The effects of coal development on the system will have to be extrapolated from small-scale tests or experiments and(or) simulated with the aid of appropriate models. The primary objective will be to define the hydrologic regime in the greatest possible detail consistent with the project duration and funding. This will include assessment of the ground-water flow system and its chemical characteristics, determination of flow magnitudes and frequencies, chemical quality, and sediment concentration and load. By defining the hydrologic regime of the study area, a second objective will be obtained--the establishment of a historical data base which will make it possible to monitor changes in the system as mining proceeds. The ultimate objective is to develop the capability of making reasonably accurate projections of the hydrologic effects resulting from the various physical treatments imposed by surface mining.

2. Approach: Existing geologic and hydrologic data and reports relating to the study area will be assembled to serve as a source of information. Additional data required to meet the objectives of the study will be outlined as completely as possible at this initial state. To gain information of the water usage in the area, a local well inventory will be conducted. Well depths, water levels, pumpage rates, and general water-quality information at each site may give an indication of current and potential water-supply problems.

An observation well network will be established to obtain water-level and ground-water-quality data for the major shallow aquifers in the area. All test holes will be logged geophysically. Some coring will be done to obtain samples of various lithologies for hydrologic and geochemical analysis. Most of the test holes will be screened and cased as observation wells.

Gaging stations will be established at selected points on the streams to provide continuous flow records. The streams will be sampled on a regular basis for water-quality analysis. These data will provide a historical record of premining conditions. Flow data will be used to project daily flow durations, peak flows at various recurrence intervals, mean annual flow, and baseflows. The water-quality data, for both surface and ground waters, will establish the utility of the water for various uses and should give some indication of the geochemical influences operational within the undisturbed flow system.

Sediment samples will be collected periodically to establish baseline conditons for sediment concentrations and loads in selected streams of the study area.

Digital models will be used to facilitate the comprehension of the existing hydrologic regime as well as enable simulation of future stresses on the system.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The M and M deposit is one of the deposits covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY 75, was scheduled for completion in FY 77, and was funded by the USGS. The deposit is covered by the County Ground-Water Resources study of Williams County completed in 1969. This study was funded under a cooperative agreement by the USGS, the North Dakota State Water Commission, and the North Dakota Geological Survey.

   Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the study. These data are being collected through programs with the North Dakota State Water Commission and with USGS funds. There will be a mutually beneficial exchange of data between the programs.

4. Distribution of Funds:

Salaries	$64,000
Travel	14,000
Laboratory Costs	8,000
Contractual Services	50,000
Equipment and Supplies	10,000
Data processing, including computer costs	4,000
Total:	$150,000

5. Reports: Basic records for surface-water quantity and surface-water quality stations will be published in the USGS annual series, "Water Resources Data for North Dakota, Water Year 19__," or as an appendix to an interpretive report. Basic records for ground-water levels and ground-water quality stations will be available to BLM and other interested parties and as an appendix to the interpretive report. The interpretive report on the hydrologic evaluation of the M and M deposit area is scheduled for review by April 1983 and will probably be published in the Water Resources Investigation series of the USGS.

D. New Leipzig Deposit

1. Objectives: The study area consists of about 150 sq mi in western Grant and eastern Hettinger Counties. However, the focus of the study will be concentrated in an area of about 20 sq mi extending about 5 mi west and 4 mi north of New Leipzig. The area is comprised of parts of two drainage basins underlain by lignite deposits. The northern basin is the uppermost part of Antelope Creek, which is tributary to the Heart River. The southern basin is the lower reach of Thirty Mile Creek, a tributary to the Cannonball River.

The primary objective will be to define the hydrologic regime in the greatest possible detail consistent with the project duration and funding. This will include assessment of the ground-water flow system and chemical characteristics, and determination of surface-water flow magnitudes, chemical quality, sediment concentration, and sediment load from available data.

The second objective will be to evaluate the historical data base which will monitor changes in the system as mining proceeds and make recommendations on the need for further hydrologic study requirements in the area.

2. Approach: Existing geologic and hydrologic data and reports involving the study area will be assembled to serve as an information framework on which to build. Additional data required to meet the objectives of the study will be outlined and collected as completely as possible. To gain information on the water usage in the area, selected local residents will be interviewed. Well depths, water levels, pumpage rates, and general water-quality information at each site may give an indication of current and potential water-supply problems.

   An observation well network has been established by the Knife River Coal Company to obtain data for the major shallow aquifers in the area. These data are available and will be used in the study. The streams will be sampled periodically for discharge, sediment, and water quality. All observation wells will be sampled for water-quality analysis.

   The study will be completed by the end of FY 81. Data compilation and analysis will commence at the initiation of the project and will constitute the major part of the project.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the study area vicinity. These data are being collected through programs with the North Dakota State Water Commission, Environmental Protection Agency, Corps of Engineers, and USGS funds. There will be a mutually beneficial exchange of data between the programs.

4. Distribution of Funds:

Salaries	$17,000
Travel	3,500
Laboratory Costs	4,000
Data Processing, including computer costs	500
Total:	$ 25,000

5. Reports: Basic records for surface-water quantity and surface-water-quality stations will be published in the USGS annual series, "Water Resources Data for North Dakota, Water Year 19__." Basic records for ground-water levels and ground-water quality stations will be available to BLM and other interested parties.

The interpretive report preparation will start upon approval of the project and wil be developed and expanded throughout the duration of the project. The topic outline will be prepared on approval and annotation added as the project progresses. The report will be scheduled for review by July 1981.

The final report is tentatively planned for the Open-File series.

II. Reconnaissance Studies

A. Investigation of the Ground-Water Resources of McKenzie County, North Dakota

1. Objectives: McKenzie County contains large deposits of federally owned lignite and is potentially one of the major lignite-producing counties of the State. Much of the lignite is saturated and in fact is the host rock for aquifers that supply water for domestic and farm use in much of the county. In view of its mining potential and the importance of ground-water supplies to the residents, it is important that ground-water information be obtained prior to mining so that the probable effects of mining may be predicted and so that land reclamation after mining be undertaken to reconstruct the aquifer systems.

   The purpose of this study is to survey and document the quantity, quality, and movement of ground water in McKenzie County. In addition, this study will provide fundamental data and quantitative interpretations on which water-management decisions can be made for municipal, domestic, industrial, and irrigation uses. Specific objectives are to: (1) determine the location, extent, and nature of major aquifers, including estimates of storage and potential yield; (2) evaluate the chemical quality of the ground water; (3) identify current and potential use of ground water; and (4) estimate and attempt to quantify the movement of ground water, including sources of recharge and discharge.

2. Approach: This is a relatively comprehensive study of the ground-water resources. Study methods are categorized by the following activities: (1) project planning, (2) water records, (3) test drilling, (4) chemical quality of water sampling and analyses, (5) aquifer tests and special studies, (6) data compilation and analysis, and (7) report preparation.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: This study is jointly funded through EMRIA funds, USGS, U.S. Park Service, North Dakota State Water Commission, and North Dakota Geological Survey.

There are no other funded projects in the county at this time.

4. Progress Through 1980: A well inventory of the county was completed with selected water samples obtained for chemical analysis. Three Fox Hills wells were drilled to fill a data gap in a cross section across the county. Available data were analyzed to establish a drilling program to fill in gaps. A network of wells was drilled to define the glacial-drift aquifers.

5. Distribution of Funds:

Salaries	$6,380
Travel	1,100
Total:	$7,480

6. Reports: Three reports will be published cooperatively by the North Dakota State Water Commission and the North Dakota Geological Survey. Part I will describe the surface geology; Part II will be a compilation of basic data, including data on existing wells and test holes; and Part III will be an interpretative report describing and evaluating the ground-water resources of the county.

III. Geochemistry Studies

A. Fort Union Coal Region Geochemistry as Related to Impacts of Strip Mining

1. Objectives: Simultaneous demands for expanded surface-mining activity, agricultural production, and urban development are placing ever-increasing strains on the land and water resources of the region. Investigations of the environmental effects of surface mining have begun to provide the data base required to make these land use decisions, but failure to understand the geochemistry of water-rock interactions may seriously limit the options for future coal development in the Fort Union coal region. Definition of these reaction mechanisms and rate-controlling factors could lead to the recognition of critical parameters governing probable water-rock interactions at other and projected

mine sites within the Fort Union region. The purpose of this investigation is to quantitatively describe major controls on the movement of important solutes in local and regional ground-water systems within the Fort Union Group affected by surface mining of lignite in western North Dakota. As has already been demonstrated, development of a quantitative understanding of principal processes of water-rock interaction requires a site-specific study. Preliminary studies suggest such an investigation of the Fort Union Group at Gascoyne would have high transference throughout the western Williston basin.

Specific objectives at the Gascoyne site will be to define the hydrogeologic and hydrogeochemical character of the shallow ground-water system in the area and to ascertain the source of observed anomalous sulfate concentrations.

2. Approach: To accomplish the obejctives, five distinct studies are required to define critical parameters.

(a) The hydrologic regime of the region must be understood in detail. An effective hydrologic model for use in geochemical evaluations must be able to provide measured and projected data on flow rates and directions (and thus residence times), water volume (yielding water-rock ratios), and the degree of confinement provided by beds of low permeability which bound aquifer units (providing leakage information). A preliminary ground-water flow model has been developed for the Gascoyne area by Droft and others but needs further refinement. Additional well sites drilled for geochemical evaluation of the area will be used to confirm and refine this model for present purposes.

(b) The mineralogy and mineral chemistry of the Fort Union Group must be determined. Combined with chemically reactive water, rock-forming minerals constitute the prime source of solutes affecting water quality. Representative mineral data is need from stratigraphically unique zones within each of the four reactant environments.

(c) Accurate determination of cation-exchange reaction rates and constants is necessary to predict the composition of ground water as it moves from a strip mine to a point of use. As expandable clay minerals comprise as much as 60 percent of the Sentinel Butte and Bullion Creek Formations of the Fort Union Group (Hinkley and Ebens, 1976), these sediments may be expected to alter significantly ground-water quality.

Smectites and vermiculites abundant in some zones within the group have an especially large capacity for adsorption and for exchange of cations in solution in ground water for those held between clay mineral layers or on clay surfaces. In additon, lignite beds and claystones comprised of nonexpanding kandites and illites also found in the Fort Union Group may have a diminished, but still high, cation-exchange capacity and may be effective in scavenging specific cations from solution.

(d) Oxidation-reduction reactions are particularly important in determining water quality in spoil banks and in lignite units. It is believed that redox reactions, possibly initiated and(or) accelerated by microbial activity, determine sulfate concentrations in local and regional ground-water systems in the northern Great Plains coal province. Measurement of the redox potential of representative samples of formation rock materials for important species pairs will define local reation conditions. Coupled with observational data of ground-water quality it will provide constraints on the magnitude of microbial activity.

(e) The solute flux derived from leaching of soluble salts from the formations and infiltration of leachate from mine spoils into formation water is to be evaluated. This process is a particularly important control on carbonate and gypsum concentrations. As leaching reactions are most intense within the spoils environment (Sandoval and others, 1973, 1975; Moran and others, 1978), this process may be the initial principal control on water chemistry in spoils pile and abandoned excavations.

3. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The proposed study will be funded jointly through EMRIA and EPA funds. Data are being collected on ground-water levels, quality of water and streamflow in the vicinity with USGS funds. There will be a mutually beneficial exchange of data between the programs.

4. Distribution of Funds:

Salaries	$18,400
Travel	2,000
Contractual Services	1,000
Supplies and Equipment	400
Laboratory Costs	2,000
Data Processing, including computer costs	200
Total:	$24,000

5. Reports: Report preparation will start upon approval of the project and will be developed and expanded throughout the life of the project. Progress reports will be prepared at the conclusion of each phase of the study, thus making documentation of data and interpretation available for use by management agencies at reasonably short intervals. Compilation of all data and interpretations will be published as a final product in the Water Resources Investigations series of the USGS.

IV. Hydrologic Modeling

A. Surface-Water Modeling, Fort Union Coal Region

1. Objectives: This project is a part of two broader scoped studies--"Hydrologic effects of mining and reclamation, Mercer County" and "Hydrologic effects of mining and reclamation, Wibaux-Beach lignite deposit"--which are scheduled to end September 1979 and September 1980, respectively. The modeling of the ground-water system will be complete by these dates, but the modeling of the surface-water system cannot be completed due to the lack of a sufficient data base. The surface-water modeling will need at least five years of data.

   Preliminary data indicate that the proposed expansion of strip-mining activities in the Beulah area may result in streamflow regimen changes. Although there are currently no mining activities in the Wibaux-Beach area, coal mining is expected in the future with probable attendant changes. Some changes will be temporary, but others will remain even after strip mining has ceased. The purpose of this investigation is to provide a means for BLM personnel or others to judge the impacts of changing land use. The objectives are to: (1) determine premining hydrologic conditions in small representative drainage basins, (2) provide historical data to compare the magnitude of change with mining, and (3) develop the capability of making reasonably accurate projections of hydrologic effects resulting from the various land treatments imposed by surface mining.

2. Approach: This will be a comprehensive study of two small representative basins. Surface models will be developed through coupling of snowmelt- and rainfall-runoff models. A distribution-parameter approach will be used in the model by having the basin partitioned into subunits based on slope, vegetation type, soil type, snow distribution, and other factors.

3. Progress Through 1980: Data collection and analysis are continuing as scheduled with the surface-water data from the regular stream-gaging stations being published in the annual report, "USGS Water Resources Data for North Dakota." The lack of snow this past season has restricted the data available for snow-distribution and snowmelt analysis. Soil-moisture data collection network has been reviewed with some sites discontinued and others established to better monitor the overall system.

A training course was held September 17 through 21, 1979, for the surface-water modelers associated with EMRIA. An update of the model and a users' guide are scheduled to be available during the summer of 1980. Simplified test runs of the model were started in February 1980 for the Beulah study area. More complex model runs, along with optimization and sensitivity analyses will be made during the rest of 1980. These efforts will dictate future model development and data collection activities. The first runs of a simplified model for the Wibaux study area will be made in 1981.

4. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The proposed study will be funded jointly through EMRIA funds and USGS Federal funds. The Wibaux-Beach and Beulah trench lignite deposits are two of the deposits covered by the hydrologic reconnaissance studies under ND-070F, which was started in FY 75, was scheduled for completion in FY 77, is in the report stage, and is funded by the USGS.

Data on streamflow, sediment loads, quality of water, and ground-water levels are being collected in the vicinity of the studies. These data are being collected through programs with the North Dakota State Water Commission and with USGS funds. There will be a mutually beneficial exchange of data between the programs.

5. Distribution of Funds:

Salaries	$128,890
Travel	17,000
Contractual Services	1,000
Supplies and Equipment	2,000
Laboratory Costs	4,500
Data Processing, including computer costs	4,500
Total:	$157,890

6. Reports: The runoff, chemical quality, and sediment data will be published annually in the series, "Water Resources Data for North Dakota, Water Year 19__." The final report is planned at the end of approximately five years of data collection, assuming a sufficient data base will be available to answer the objectives. The report will probably be published in the series, "Water-Resources Investigations," or some type of open-file report. The model will be retained on diskettes and/or disk for future use. Progress reports will be furnished periodically as needed.

V. Hydrologic Monitoring of Coal Areas

A. Network maintenance of observation wells, stream discharge water-quality stations, and flood plain delineation.

1. Objectives: (1) To collect monthly water levels for one more year on about 45 wells. The data will supply enough information to define seasonal fluctuations of ground-water levels to supplement the information obtained under EMRIA studies of the Wibaux-Beach deposit and the Beulah Trench area. (2) To collect continuous streamflow and intermittent water-quality samples at two sites to supplement data collected under an EMRIA study. The additional data are essential in defining the runoff and quality of water from potential impact areas. (3) To define the flood plain on Spring Creek from Lake Ilo downstream to the vicinity of the city of Werner and on Brush Creek for two miles above and below the crossing on State Highway 49.

2. Approach: Standard U.S. Geological Survey methods of water-level measurement and surface-water and quality of water data collection will be used. Quality of water samples will be obtained on the basis of stream discharge magnitude, probably from one to four samples at each site. Table 1 lists the water-quality parameters in the analysis. The flood plain delineation will be based on the 1 percent exceedance probability (100-year) flood. The discharge will be computed from regional equations and the discharge records from the gaging stations--Spring Creek at Zap and Brush Creek near Beulah. It will be necessary to delineate from Lake Ilo to Zap on Spring Creek to assure continuity. The delineation will be on 7-1/2 minute topographic quadrangles.

3. Relationship to Other Closely Associate Non-EMRIA Funded Activities: Data on streamflow, quality of water, and ground-water levels are being collected in the study vicinity through programs with the North Dakota State Water Commission and the Corps of Engineers, and with USGS funds. There will be a mutually beneficial exchange of data between the programs. The flood plain maps would complement others prepared for the general area under a cooperative program with Housing and Urban Development.

4. Progress Through 1980: The sites to be monitored under this program were established under EMRIA studies and records were collected in 1980 under these same studies.

5. Distribution of Funds:

Salaries	$11,000
Travel	2,500
Laboratory Costs	600
Data Processing	300
Equipment (rental) and printing	200
Total:	$14,600

6. Reports: Data for surface-water quantity and quality will be published in the USGS annual series, "Water Resources Data for North Dakota, Water Year 1981." Basic records for ground-water levels will be available to BLM and other interested parties from computer storage and can be obtained in hydrograph format. The flood plain delineations will be furnished on full-size prints of 7-1/2 minute quadrangles.

Table 1. NORTH DAKOTA. LIST OF WATER QUALITY PARAMETERS.

Hydrologic Studies	
Field	
Discharge (ft^3/s)	SW only
Temperature (°C)	
pH	
Specific conductance	
Laboratory	
Alkalinity (Tot as $CaCO_3$)	
Boron, Diss	
Calcium, Diss	
Chloride, Diss	
Fluoride, Diss	
Hardness, Noncarb	
Hardness, Total	
Iron, Diss	
Magnesium, Diss	
Manganese, Diss	
Molybdenum, Diss	
Nitrogen, Diss KJD	SW only
Potassium, diss	
Residue, Calc Sum	
Residue, Diss Ton/Aft	SW only
Residue, Diss Ton/Day	SW only
SAR	
Silica, Diss	
Sodium, Diss	
Sodium, Percent	
Strontium, Diss	
Sulphate, Diss	
Susp. Sed. Conc.	

VI. Airborne Snow Surveys

A. Objectives: Due to accompanying winds of varying intensities and directions, snow occurring over the northern Great Plains does not distribute uniformly. As the sophistication of snowmelt and runoff models increases, the need for accurate, timely snow-cover inforamtion also grows. Regardless of watershed size, an effective model requires a really distributed snow-cover depth and water-equivalent data. The latter provides knowledge of the stored water volumes available for runoff, while a measure of snow thickness indicates the expected rate of melt- and channel-water movement.

The present snow survey methods are inadequate in the Great Plains environment without a cost-prohibitive manpower requirement.

The objectives of the study are: (1) to investigate the possibilities of combining airborne snow survey and landscape-stratified sampling techniques to determine snow water equivalents at selected landscape units; (2) to compare snow-cover densities for selected land-use types (stubble, fallow, brush, etc.) as determined by airborne and ground snow surveys, with the anticipation that snow-cover density could be monitored remotely from aircraft, leaving snow-depth measurements for rapid ground-based collection; and (3) to evaluate the error associated in passing a gamma radiation scintillation counter (NAI) rapidly over snow covers differing in depth, water equivalent, and slope position such as evidenced on steep slopes of prairie ravines and large coulees.

B. Approach: Two methods of making snow surveys will be used to obtain the objectives of the study. The first is a ground snow survey using a terrain type land-use method as outlined by Steppuhn and Dyck (1974). Pastures, cultivated fields, sloughs, brush, etc., within the same climatic region tend to accumulate snow according to recurring patterns unique to specific terrain type and land use. Therefore, snow samples collected within similar areal units result in a statistically valid estimate of true snow water equivalents.

The second method is an airborne snow survey system based on the attenuation of natural terrestrial gamma radiation due to snow cover. The operational program serves primarily National Weather Service River Forecast Centers in the upper Midwest. The merits of a calibration flight line to accurately index the actual mean areal snow cover over the entire watershed will be examined.

C. Relationship to Other Closely Associated Non-EMRIA Funded Activities: The study is funded jointly through EMRIA funds and U.S. Geological Survey Federal funds with direct services contribution by the National Weather Service. The project will result in a mutually beneficial exchange of information with streamflow and snowmelt-runoff programs with the North Dakota State Water Commission and the Corps of Engineers and U.S. Geological Survey.

D. Distribution of Funds:

Salaries	$19,600
Travel	5,000
Computer	500
Total:	$25,100

E. Reports: A preliminary report is planned by September 1981. The final report will be completed at the end of the study and depends on the duration of the investigation. The report will probably be in the series "Water-Resources Investigations" or some type of open-file report. Progress reports will be furnished periodically as needed.

Oklahoma

OKLAHOMA

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA FUNDS
Hydrologic Investigations - Blocker Area	$ 61,250
Hydrologic Investigations - Rock Island Area	38,600
Hydrologic Investigations - Red Oak Area	53,600
Hydrologic Investigations - Stigler Area	57,500
Sediment Studies - 12 sites	109,800
Watershed Characteristics	20,000
Hydrologic Model - Coal Creek near Lehigh	125,900
Total:	$466,650

I. Introduction

A. Purpose and Scope: BLM is responsible for assessing the probable water resources impacts and reclamation capabilities of any area under Federal jurisdiction in which surface coal mining might occur. To meet this responsibility, a variety of hydrologic data are required. In Oklahoma, these areas are being provided by: (1) hydrologic monitoring in selected areas, and (2) hydrologic modeling of Coal Creek basin near Lehigh. In addition, hydrologic data are also being generated by the Survey's monitoring program at 12 sites in the coal field and sediment data collection at these 12 sites under the auspices of the BLM.

Areas near Blocker, Rock Island, Red Oak, and Stigler have been identified as having high potential for mining of Federal coal. Hydrologic data collection in the Blocker and Rock Island areas began in 1976 and in the Red Oak and Stigler areas in 1978.

II. Hydrologic Investigations

A. Blocker Area

1. Blue Creek near Blocker

a. Continue surface-water gaging station.

b. Collect samples as scheduled.

2. Blue Creek Tributary near Blocker: Make instantaneous discharge measurement at time samples are collected.

3. Mathuldy Creek near Crowder: Make instantaneous discharge measurement at time samples are collected.

4. Maintain ground-water level recorder near Blocker.

5. Maintain rain gage near Blocker.

6. Sample Frequency

a. Monthly--common constituents and nutrients.

b. Semi-monthly--field parameters, dissolved and total metals, and sediment.

c. Semi-annually--bottom materials.

7. Suites of Analyses--See Attachment A.

8. Reports

a. Streamflow, stream-water quality, and sediment data will be published in the annual data report.

b. Complete report on the hydrology of the Blocker area including all basic data collected as of September 30, 1979. The report draft will be delivered to Denver Service Center EMRIA staff by July 30, 1980.

B. Rock Island Area

1. James Fork near Hackett, AR: Collect samples as scheduled.

2. James Fork near Williams: Make instantaneous discharge measurement at time samples are collected.

3. Maintain ground-water level recorder.

4. Maintain rain gage near observation well.

5. Sample Frequency and Suites of Analyses: Same as for Blocker area.

6. Reports

a. Streamflow, stream-water quality, and sediment data will be published in the annual data report.

b. Complete report on the hydrology of the Rock Island area including all basic data collected as of September 30, 1979. The report draft will be delivered to Denver Service Center EMRIA staff by July 30, 1980.

C. Red Oak Area

1. Brazil Creek near Walls below mining area

a. Continue surface-water gaging station.

b. Collect samples as scheduled.

2. Brazil Creek near Red Oak above mining area: Make instantaneous discharge measurement at time samples are collected.

3. Rock Creek near Red Oak above mining area: Make instantaneous discharge measurement at time samples are collected.

4. Maintain ground-water lever recorder.

5. Maintain rain gage.

6. Sample Frequency and Suites of Analyses: Same as for Blocker area.

7. Reports

   a. Streamflow, stream-water quality, and sediment data will be published in the annual data report.

   b. Complete preliminary report on the hydrology of the Red Oak area.

D. Stigler Area

1. Taloka Creek near Stigler below mining area

   a. Continue surface-water gaging station.

   b. Collect samples as scheduled.

2. Taloka Creek near Stigler above mining area: Make instantaneous discharge measurement at time samples are collected.

3. Maintain ground-water level recorder.

4. Maintain rain gage.

5. Sample Frequency and Suites of Analysis: Same as for Blocker area.

6. Reports

   a. Streamflow, stream-water quality, and sediment data will be published in the annual data report.

   b. Complete preliminary report on the hydrology of the Stigler area.

III. Sediment Studies

Sediment samples will continue to be collected at each of the sites listed below. They are operated under the USGS Coal Hydrology Monitoring Program. Samples are collected once daily by observers at Muddy Boggy River at Atoka and at Caston Creek at Wister; the other sites are sampled automatically by PS-69 samplers.

A. Brushy Creek near Haileyville
B. Caston Creek at Wister
C. Coal Creek near Spiro
D. Deer Creek near McAlester
E. Fourche Maline near Wilburton
F. Holi-Tuska Creek near Panama
G. Morris Creek at Howe
H. Muddy Boggy River at Atoka
I. Owl Creek near McCurtain
J. Peaceable Creek near Haileyville
K. Red Oak Creek near Red Oak
L. Sugarloaf Creek near Monroe

IV. Watershed Characteristics

A. Complete hydrologic analysis and prepare report on Pecan Creek basin.

B. Maintain rain gages in selected areas.

V. Hydrologic Modeling - Coal Creek Basin near Lehigh, Oklahoma

A. Surface Water Flow Regime

1. Coal Creek

a. Continue surface-water gaging station.

b. Continue crest stage gage.

2. Coal Creek Tributaries

a. Continue crest stage gages.

b. Make periodic discharge measurements.

B. Stream Water Quality

1. Coal Creek

a. Continue water-quality monitor for pH, specific conductance, dissolved oxygen, and temperature.

b. Continue automatic water sampler to collect suspended sediment samples daily and during selected runoff events.

c. Continue monthly water sample collection and during selected runoff events for analysis of common constituents and nutrients.

d. Collect approximately 30 water samples, divided between runoff events and baseflow, for metals analysis.

e. Collect water samples quarterly for organic carbon analysis.

2. Coal Creek Tributaries

a. Continue single-stage sediment samplers.

b. Continue water samples collection quarterly to determine field parameters, common constituents, nutrients, metals, and organic carbon.

C. Ground-Water Regime

1. Continue ground-water level recorder.

2. Make annual mass measurement of all accessible wells in the basin and selected wells outside the basin.

D. Climatological Data

1. Continue operating continuous climatological station to determine air temperature, relative humidity, solar radiation, precipitation, and wind speed and direction.

2. Continue operation of three continuous precipitation gages.

3. Continue periodic soil moisture measurement at 12 sites.

E. Preliminary Modeling: Make preliminary model calibration with respect to rainfall-runoff, sediment transport and other parameters, if feasible.

F. Reports

1. Streamflow, stream-water quality, and sediment data will be published in the annual data report.

2. Prepare report including all basic data collection as of September 30, 1979.

3. Start hydrology of Coal Creek basin report.

4. If warranted, start report on preliminary model calibration results.

Attachment A.

Analytical Suites

Field Parameters

00400	pH
00095	Specific conductance
00010	Water temperature
00300	Dissolved oxygen
	Instantaneous water discharge

Common Constituents -- DISSOLVED

00955	Silica
00915	Calcium
00925	Magnesium
00930	Sodium
00935	Potassium
00410	Alkalinity
00940	Chloride
00945	Sulfate
00950	Fluoride
70300	ROE at 180° C
00800	Color
00076	Turbidity

Nutrients

	Dissolved	Total
Nitrogen, Kjeldahl	00623	00625
$NO_3 + NO_2$	00631	00630
Phosphorous	00666	00665

Metals

	Dissolved	Total
Aluminum	01106	00105
Arsenic	01000	01002
Boron	01020	01022
Cadmium	01025	01027
Chromium	01030	01034
Copper	01040	01042
Iron	01046	01045
Lead	01049	01051
Manganese	01056	01055
Mercury	71890	71900
Molybdenum	01060	01062
Zinc	01090	01092

Calculated Values

Sodium adsorption ratio (SAR)
Total hardness
Dissolved solids tons/acre feet

Bottom Materials

00626	Nitrogen, Kjeldahl
00633	$NO_3 + NO_2$
00668	Phosphorous
01108	Aluminum
01003	Arsenic
01028	Cadmium
01034	Chromium
01043	Copper
01170	Iron
01052	Lead
01053	Manganese
71921	Mercury
01063	Molybdenum
01093	Zinc

Utah

UTAH

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA	OTHER
Hydrology of Kaiparowits, Alton, and Kolob Coal Fields	$125,000	
Hydrology, Central Wasatch Plateau (UT-930-4110-1125) (State EMRIA Funds)	125,000	
Floodplain Mapping	100,000	
Hydrology, Price River Basin		125,000
Hydrology Study, Uinta Basin (gaging station, mouth of White River)		14,300
Cooperative State Programs (UT 1, 3, and 4)		53,050
Total:	$350,000	$192,350

Total for the State of Utah: $542,350

I. Hydrologic Reconnaissance in the Kaiparowits-Alton-Kolob Coal Fields.

A. Location: BLM is required to evaluate a number of known coal-resource areas in Utah to determine environmental suitability for mining and impacts on the water resources. The remaining area requiring a reconnaissance hydrologic study of greatest priority includes the Kaiparowits Plateau, the Kolob coal field, and the Alton area.

B. Objectives: To define the hydrologic system and, where possible, to identify or predict the effects of coal mining on the water resources. The report for the study would be published in the Water-Supply Paper series and would be prepared by September 1983.

C. Approach: During FY 81-83, work would concentrate on defining the quantity and quality of surface water and extent and characteristics of aquifers above, within, and directly below the coal-bearing rocks. Major work items and their approximate order of completion in each study would include, at a minimum, a literature and file search for existing data; a detailed planning document that includes a work schedule and report outline; a well and spring inventory; an inventory of water use and discharges from mines; water sampling from selected wells and springs for chemical analyses; miscellaneous discharge measurements and water sampling to define seasonal variations in surface-water quality and losing and gaining reaches of streams; aquifer tests on existing wells; construction of observation wells, when possible, in test holes drilled by private companies or other Federal agencies; and report preparation and review.

D. Distribution of Funds:

Planning	$ 20,000
Data Collection	28,000
Data Processing and Analysis	12,000
Laboratory Support	12,000
Supplies and Equipment	4,000
Computer Services	500
Travel	8,000
Overhead (District and National Headquarters)	40,500
Total:	$125,000

II. Hydrology of the Central Wasatch Plateau, Sanpete, Sevier and Emery Counties, Utah (78-135-1).

A. Objectives: During June 1978 to September 1981, to provide hydrologic information for the central Wasatch Plateau so that BLM can make reasonable stipulations in future coal leases to minimize the disturbance of the hydrologic system and sources of water supply. The specific objectives of this study are: (1) Define the extent and characteristics of aquifers above, within, and immediately below the coal-bearing sections of the Blackhawk Formation. Also define areas of aquifer recharge and discharge and the quantity and quality of water held in storage in each aquifer. (2) Determine the existing seasonal variation in the quantity and quality of surface water and stream aquatic life. (3) Estimate volumes of runoff and peak flows from 10- and 25-year, 24-hour storms and the peak runoff from the 2- and 100-year storms. Also map areas inundated by the 100-year flood. (4) Determine the location and sources of water supply for significant domestic, agricultural, industrial, and other uses. Identify municipal watersheds and aquifers that are the sole source of supply for public use. Determine the existing seasonal variability in quantity and quality for the major sources of supply. (5) Where possible, predict the effects of underground coal mining and associated surface facilities on the quantity and quality of surface and ground water and stream aquatic life, with emphasis on aquifers and watersheds that are the sole source of a public water supply.

B. Approach: Hydrologic data will be collected during coal-exploration drilling by Federal, State, and private organizations. This will include monitoring, when possible, the quantity of water into and out of the holes during drilling to locate water-producing zones; the addition of thermal logging to the standard geophysical logs to locate changes in fluid-temperature gradients, and the installation of 2-inch I.D. PVC casing in selected holes to make observation wells. Observations of water-level fluctuations and, where possible, sampling and aquifer testing will be conducted on all cased holes. Further knowledge of the ground-water system will be obtained from a spring inventory and sampling program. Seepage runs will be made on the major streams.

Design-flood runoffs and peaks will be estimated by multiple regression of basin characteristics. Flood-prone areas will be delineated. Aquatic-biota surveys and surface-water sampling for chemical quality and sediment will also be conducted.

C. Progress: Four observation wells have been completed in the study area. Lithologic, electric, and temperature logs have been made of several exploratory drillholes. The spring inventory, started in 1978, has been continued by field checking of hundreds of springs shown on a map prepared by the U. S. Forest Service. Water-quality samples, suspended sediment, and samples of benthic organisms have been collected on all major streams. Seepage runs showed no significant gains or losses. Samples of ground and surface water have been collected within and around the Southern Utah Fuel Co. mine in Convulsion Canyon. A relationship using watersheds similar to those in the study area has been established to predict the discharge, volume, and height of floods. A base map has been completed at a scale of 1:250,000.

D. Plans for Next Year: Continue data collection at springs and mines. One week will be spent analyzing ground water from wells, springs, and mines to detect differences in fluorocarbon concentrations. Conduct seepage runs on small streams and across faults on larger streams. This will enable "dating" of water and give information on recharge and ground-water movement. Collect water samples from storm runoff as available. Prepare final report.

E. Reports: An administrative report to the BLM was prepared on the North Horn Mountain area using preliminary data and interpretations.

F. Distribution of Funds:

Data Collection	$ 11,000
Laboratory Support	6,000
Supplies and Equipment	500
Computer Services	7,000
Travel	3,500
Report Preparation and Review	57,000
Overhead (District and National Headquarters)	40,000
Total:	$125,000

III. Flood-Plain Mapping in BLM-Administered Lands in the West, with Emphasis on Coal-Lease Areas. A Review of Methodology and Recommendations for Delineating Areas Inundated by Floods of Selected Return Periods

To formulate land-use plans, the BLM is requesting assistance in outlining areas inundated by floods of selected frequencies. Passage of Public Law 95-87, Surface Mining Act, makes it necessary to delineate flood plains at many locations in the west. First priority is outlining areas inundated by the 100- and 500-year floods in areas of known recoverable coal resources. For example, in Utah, about 40 townships in the vicinities of Alton, Kaiparowits Plateau, Kolob, Emery, Wasatch Plateau, and the Book Cliffs are of immediate concern. This information is also needed in from 6-10 other states in the West.

Using Utah as an example, reports by Wolley (1946), Somers (1957), Butler and Mundorff (1968), Whitaker (1969), Butler and Cruff (1971), and Butler and Marsell (1972), summarize maximum floods at many continuous-record stations and miscellaneous sites. Methods for estimating the frequency and magnitude of floods at ungaged sites are reported by Berwick (1962), Thomas, Broom, and Cummens (1963), Butler, Reid, and Berwick (1966), Patterson and Somers (1966), Fields (1974), and Eychaner (1976). Nine flood-prone area maps have been completed for Utah. The Geological Survey has not completed any FIA studies in Utah and has completed very few FIA studies in the other western States. Even though numerous flood reports have been published, they are primarily lists of maximum flows of record. They provide methods of calculating flood-frequency relations at gaged and ungaged sites with no emphasis on instructions for outlining areas inundated by floods of selected frequencies.

A. Objectives: (1) Provide methods for outlining areas inundated by floods of selected frequencies, (2) describe the hydraulic and hydrologic factors that must be considered when preparing flood-plain maps, and (3) publish a report outlining procedures for flood-plain mapping including profiles of historic floods, profiles of theoretical floods, FIA studies, and "quick and dirty techniques."

   Although much of the effort will be in evaluating existing data and methodology, new relations for estimating flood depths for selected return periods will be developed. The depths above median discharge for all sites with more than five years of record will be related to basin and climatic characteristics by multiple-regression techniques. In addition, recommendations will be given for when to use "quick and dirty techniques" versus more complicated ones based on accuracy and available manpower.

B. Reports: A Water-Supply Paper, which will essentially be a "manual" that can be used by BLM and other interested parties to determine areas that would be inundated by floods of different recurrence intervals. The report will contain a few representative flood maps.

C. Staff: Hydrologist, GS-13, available in Utah. Hydrologic technician, GS-5-11, available in Utah. Other personnel as needed in other States.

D. Funding: $100,000.

E. Period: FY 1981-82.

IV. Hydrology of the Price River Basin, with Emphasis on Areas Underlain by Coal. Utah (79-138-1)

A. Objectives: From October 1978 to September 1981, to determine the effects of present and proposed coal mining on the hydrology of the Price River Basin. Specifically, to determine the effects of coal mining (including the effects of existing and potential land subsidence) on surface-water quantity, quality, and biology; ground-water recharge, movement, discharge, and quality; and sediment yields.

B. Approach: Study the occurrence of ground water in the basin including recharge, movement, discharge, and aquifer properties. Evaluate surface-water supplies, including variability of streamflow, flood-prone areas, biological characteristics, and sediment yields. Determine surface-water--ground-water relationships and the chemical characteristics of ground and surface water. Study the occurrence of water in existing coal mines, and evaluate the effects of mining on the hydrologic system.

C. Progress

1. Installed and operated five rain gages in the Scofield Reservoir area.

2. Made aquatic-biotic survey at 14 sites during July and October 1979.

3. Collected bed-material samples at benthic invertebrate sampling sites.

4. Conducted limnologic bathymetric and bottom-core surveys in Scofield Reservoir.

5. Collected water-quality information on all streams flowing into and out of Scofield Reservoir during low flow of snowmelt-runoff periods.

6. Began frequent monitoring of spring discharge in the Soldier Creek and Scofield Reservoir areas during April and May 1980.

7. Operated continuous gages on two streams in the Scofield area and established rating curves with frequent measurements during snowmelt-runoff period.

8. Operated continuous-record gage on spring flow in Clear Creek.

9. Conducted detailed seepage studies along relocated stream reaches.

10. Collected multiple water-quality samples of snowmelt runoff for selected streams in the Scofield area.

D. Plans for Next Year

1. Calibrate mountain-watershed model for selected subbasins.

2. Prepare water budgets for selected subbasins.

3. Test selected wells (in cooperation with private coal company) in the Book Cliffs area to determine the potentiometric surfaces and occurrences of water in selected aquifers.

4. Conduct additional seepage studies.

5. Utilize fluorocarbon dating techniques in an attempt to determine ground-water source and direction of movement.

6. Complete basic-data report and two interpretive reports (one on the entire study, and one on Scofield Reservoir).

E. Distribution of Funds:

Salaries	$ 62,000
Travel	8,000
Laboratory Support	7,000
Supplies and Equipment	5,000
Computer Services	3,000
Overhead (District and National Headquarters)	40,000
Total:	$125,000

V. Hydrologic Study of Uinta Basin, Utah

A. Location: Southeastern Uinta Basin, about 2,400 sq mi

B. Objective: To collect streamflow and sediment data in FY 1981.

To continue depending on annual appropriations.

C. Approach

1. Operate streamflow gaging station at 1 site:

09306900 White River at mouth near Ouray, Utah, in SE1/4SE1/4 NW1/4 Sec. 2, T9S, R20E, Uintah County, Lat. 40°03'54", Long. 109°38'06".

2. Collect daily sediment samples at gaging site shown under item 1 and calculate daily suspended-sediment loads.

D. Reports: Information will be included in normal basic data Utah District reports. BLM may request data directly if needed.

E. Distribution of Funds:

Salaries	$ 3,700
Sediment Observer	1,100
Travel and Transportation	1,410
Supplies and Equipment	140
Laboratory Support	2,750
Data Processing and Report	700
Overhead (District and National Headquarters)	4,500
Total:	$14,300

VI. Cooperative State Program UT 1, 3 and 4.

A. Objective: To determine the sediment, salinity and discharge of water resources in the San Rafael River, Muddy River, and Sevier River drainages and the Pariette Wash area, in Emery, Wayne, Sevier, and Uintah Counties, respectively, Utah.

B. Approach: Provide for the operation and maintenance of sediment, water quality, and gaging station operations on the following waters during FY 81 as listed below:

UT-1 Collection and basic records, surface water

Ferron Creek near mouth, near Clawson	$ 3,700
Muddy Creek, 3 miles above Salt Wash	3,700
San Rafael River, at S.R. campground, near Castle Dale	3,700
Pariette Draw below Pleasant Valley Wash, near Myton	3,700
Pariette Draw at mouth, near Ouray	3,700
Lamb Diversion, at Pariette Draw, near mouth	3,700
Cottonwood Creek near Orangeville	3,700
Otter Creek at Koosharem	3,700
Total:	$29,600

UT-3 and 4 Collection of basic records, chemical quality and sediment

Ferron Creek, near mouth, near Clawson	$ 3,350
Muddy Creek, 3 miles above Salt Wash	3,350
San Rafael River, at S.R. campground, near Castle Dale	3,350
Pariette Draw, below Pleasant Valley Wash, near Myton	3,350
Pariette Draw, 5 miles above mouth	3,350
Pariette Draw at mouth, near Ouray	3,350
Cottonwood Creek near Orangeville	3,350
Total:	$23,450

C. Distribution of Funds: Appropriation Code 4340-5273. $53,050

Wyoming

WYOMING

SUMMARY OF FUNDS
WATER RESOURCES DIVISION

PROJECT	EMRIA FUNDS	OTHER
HYDROLOGIC MONITORING		
Surface-Water-Network		
Powder River Basin	$ 9,710	---
Green River, Great Divide and Bear River Basins	97,920	---
Hanna Basin	29,130	---
Other Basins	52,520	---
Precipitation, Infiltration, and Runoff Relations - Small Basins	67,700	---
Quality of Runoff from Plains Areas	52,000	---
Streamflow Characteristics	73,600	---
O&M Ryckman Creek Gaging Station		$7,100
Totals:	$382,580	$7,100

WYOMING

I. Hydrologic Monitoring-Surface-Water Network

A. Powder River Basin

1. Location: Powder River Basin in northeastern Wyoming.

2. Objectives

a. Determine runoff characteristics for watersheds in or near areas of extensive coal deposits.

b. Determine the physical effects of coal mining and land reclamation on surface runoff and ground-water recharge.

c. Determine the chemical and biologic quality of surface water and sediment transport in streams.

3. Procedures: Operate the stream gage listed below. Approximately 19 additional stations supporting this activity will be operated and funded under the USGS Coal Hydrology Program.

Station Number and Name	SW	GW	Sed.	Total
06365300 Dry Fork Cheyenne River near Bill, WY	$4,520	$4,440	$ 750	$9,710
TOTALS	$4,520	$4,440	$ 750	$9,710

4. Report Procedures: Publish basic data in annual report of USGS. Use the data in preparing interpretive reports.

B. Green River, Great Divide, and Bear River Basins

1. Location: Green River, Great Divide, and Bear River Basins of Wyoming.

2. Objectives:

a. Determination of runoff characteristics for watersheds in or near areas of extensive deposits of coal and oil shale.

b. Determination of the physical effects of coal mining, land reclamation, and in situ oil shale reporting on surface runoff and ground-water recharge.

c. Determination of the chemical and biologic quality of surface water and sediment transport in streams.

3. Procedures:

a. Operate the stream gages listed below. Water-quality samples will be collected at sites where monitors or samplers are installed. Field observations of temperature and specific conductance will be made at all other sites.

Station Number and Name	SW	QW	Sed.	Total
09214500 Little Sandy Creek above Eden	$ 4,520	$ 180	$ 1,210	$ 7,200
09216527 Separation Creek near Riner	4,520	180	1,380	6,080
09216562 Bitter Creek above Salt Wells Creek, near Salt Wells	4,520	8,060[1]	1,380	13,960
9216565 Salt Wells Creek near South Baxter	4,520	7,230	6,220	17,970
09216750 Salt Wells Creek near Salt Wells	4,520	7,230	9,450[2]	21,200
09222300 Little Muddy Creek near Glencoe	7,420[3]	5,760	1,380	14,560
09222400 Muddy Creek near Hampton	4,520	180	1,380	6,080
09235300 Vermillion Creek near Hiawatha	4,520	180	1,380	6,080
10027000 Twin Creek at Sage	4,520	180	1,380	6,080
TOTALS	$43,580	$29,180	$25,160	$97,920

4. Report Products: Publish basic data in annual reports of USGS. Use the data in preparing interpretive reports.

C. Hanna Basin:

1. Location: Hanna Basin in south-central Wyoming.

1/ Includes $1,100 for moving SP-22 monitor from Dry Canyon.

2/ Includes $3,300 for moving PS-69 sediment sampler and SP-22 monitor from Separation Creek.

3/ Includes $2,900 for moving station upstream to be above power plant effluent.

2. Objectives:

a. Determine runoff characteristics for watersheds in or near areas of extensive coal deposits.

b. Determine the physical effects of coal mining and land reclamation of surface runoff and ground-water recharge.

c. Determine chemical and biological quality of surface and ground water and sediment transport in streams.

3. Procedure: Operate the stream gages listed below.

Station Number and Name	SW	QW	Sed.	Total
06630300				
Big Ditch near Coyote Springs	$4,520	$4,440	$ 750	$ 9,710
06630330				
North Ditch near Coyote Springs	4,520	4,440	750	9,710
06634990				
Hanna Draw near Hanna	4,520	4,440	750	9,710
TOTALS	$13,560	$13,320	$2,250	$29,130

4. Report Products: Analyze data and prepare progress reports as significant data become available. Publish basic data in annual reports of USGS. Use the data in preparing interpretive reports.

D. Other Basins

1. Location: Big Horn and North Platte Basins.

2. Objectives

a. Determine runoff characteristics for watersheds in or near areas of extensive coal deposits.

b. Determine the physical effects of land use on surface runoff and ground-water recharge.

c. Determine the chemical and biologic quality of surface and ground water and sediment transport in streams.

3. Procedure: Operate the stream gages listed below.

Station Number and Name	SW	QW	Sed.	Total
06207510 Big Sand Coulee at Wyoming-Montana State Line	$ 3,030	$ 790	$ 5,980	$ 9,800
06256900 Dry Creek near Bonneville	4,520	1,020	4,200	9,740
06267400 East Fork Nowater Creek near Colter	—	1,200	6,220	7,420
06267900 Middle Fork Fifteenmile Creek near Worland	—	1,200	1,680	2,880
06268500 Fifteenmile Creek near Worland	4,520	1,200	6,220	11,940
6278000 Dry Creek near Greybull	4,520	1,200	—	5,720
06628800 Sage Creek near Saratoga	3,030	1,170	820	5,020
TOTALS	$19,620	$7,780	$25,120	$52,520

4. Report Products: Publish basic data in annual reports of USGS. Use the data in preparing interpretive reports funded from other sources.

E. Hydrologic Monitoring: Total Funding $189,280.

II. Precipitation, Infiltration, and Runoff Relations for Small Basins in Wyoming.

A. Location: Wyoming, statewide.

B. Objectives: Federal regulations regarding surface coal mining and reclamation specify that precipitation-frequency criteria be used for hydraulic design. Very little data are available to define the precipitation-runoff relation. This project is designed to develop methods for accurately estimating runoff volumes from small drainage basins for selected precipitation frequencies. Specifically, the objective is to define infiltration-rate curves for soil and other surficial material by an incipient-ponding-curve method developed by Craig and Rankl (USGS).

C. Procedure: This incipient-ponding-curve will be expanded to cover a number of additional basins with differing soil characteristics so that the infiltration model will have wide transferability throughout Wyoming.

D. Report Products: The final report, which will be prepared in FY 82, will describe the methods, soil types, and the ponding equations. It will be published in the Water-Resources Investigation Series.

E. Distribution of Funds:

Salaries	$59,100
Travel	2,900
Computer	3,000
Equipment	2,700
Total:	$67,700

III. Quality of Runoff from Small Basins in Plains Areas of Wyoming.

A. Location: Wyoming, statewide.

B. Objectives: Most energy-mineral development in Wyoming is planned for plains areas characterized by ephemeral and intermittent streams. Because of the flashy nature of precipitation and streamflow in these areas, water quality is highly variable and difficult to measure or predict. As a result of this variability, monthly water-quality data do not adequately describe baseline conditions against which future conditions may be compared. More importantly, without adequate knowledge of sources and processes involved in the transport of dissolved and absorbed constituents within the basin, little can be said about expected impacts on water quality resulting from proposed development. Time allowed for data collection and interpretation is not sufficient to develop the desired functional relations by routine, monthly monitoring.

Specific objectives are to: (1) identify dominant processes involved in the divestment and transport of constituents (such as salinity, nutrients, and trace elements) by intermittent and ephemeral streams, and (2) document short-term data collection methods and interpretation used so they may be applied to similar, unstudied basins.

C. Procedure: Existing data collected from two small plains areas in southwestern Wyoming would be analyzed along with data to be collected intensively during runoff events. Relation developed by this study would tentatively include wash-off coefficients (similar to those currently used in urban stormwater modeling), source of and variation in composition of constituents in runoff, and accumulation rates of constituents on basin surfaces.

D. Report Products: The final report, which will be prepared during FY-81, will include the processes identified and all short-term data collection and interpretation methods used.

E. Distribution of Funds:

Salaries	$42,700
Travel	2,600
Chemical Analyses	1,600
Data Processing	5,100
Total:	$52,000

IV. Streamflow Characteristics of Energy-Mineral Areas in Wyoming.

A. Location: Wyoming, statewide.

B. Objectives: Information relative to streamflow in the energy areas of Wyoming is inadequate for proper planning, designing, and monitoring of the effects of energy-resource development. Data for developing predictive techniques have been particularly scarce for small intermittent and ephemeral basins. Yet, most existing or proposed mines in Wyoming occur in small basins that have only intermittent or ephemeral streams.

The objective is to provide techniques that will allow accurate estimates of monthly and annual runoff characteristics for streams in the energy areas, with emphasis on intermittent and ephemeral basins.

C. Procedures: The approach will essentially be an extension of work done by Lowham (USGS) and by Craig and Rankl (USGS), both of which used data available through 1973. Considerable new data are now available. A regional analysis will be made based on average records, and a time-series analysis will be made of monthly and annual runoff to define time distribution. Channel-geometry methods will be reviewed to determine ways to improve these techniques, which should be highly transferable throughout the energy areas. Special emphasis will be placed on coal outcrop and adjacent areas.

D. Report Products: The final report, which will be prepared during FY 81, will summarize data and techniques as well as describe transferability of both.

E. Distribution of Funds:

Salaries	$65,800
Travel	3,400
Equipment	1,000
Computer	3,400
Total:	$73,600

V. O&M of One Gaging Station (WY-930-4340-5273)

A. Location: Black's Fork Subbasin, Ryckman Creek Watershed. Section 8, T. 18 N., R. 117 W.

B. Data Collection

1. Site selection and setup was done in 1980. Operation should last for 5 years.

2. Type and Frequency

a. Discharge: Daily.

b. Quality: Field determinations, total dissolved solids, and suspended sediment - monthly.
Cation/anion analysis analysis- quarterly.
Trace metals - quarterly.

C. Funding: Non-EMRIA.

Surface Water	$4,520
Chemical Quality	1,200
Sediment	1,380
Total:	$7,100

Central Region

Office of Public Land Hydrology

I. Modeling Water Relations in Soils of Surface Mineable Areas in Different Climate Regions.

A. Problem: Soils that are restructured over spoils after surface mining must have hydrologic properties similar to soils that originally covered these areas, since reestablishment of cover and a similar hydrologic response are required by law. Vegetative and hydrologic response to soil properties differ as climatic factors vary.

B. Objective: The objective of the study is to investigate the interaction of different forms, amounts and intensities of precipitation with the average void size down through soil profiles as indicated by the ratios of void space to particle surface area for successive depth increments. Soils on areas having potential for surface mining will be studied to provide prescriptions for restructuring the soils after mining to produce the desired or required vegetative and hydrologic responses. The acquired information will also have application to management of rangeland resources.

C. Approach: The problem will be approached by continuing to cooperate with WRD District Personnel in small basin modeling studies being conducted in Alabama, Oklahoma, Colorado, North Dakota, Montana, and New Mexico. A wide range of climatic conditions, from arid to humid, is represented by the spread of basin locations. Soil hydrologic properties have already been characterized for various hydrologic response units in each basin. Neutron soil-moisture monitoring sites have been established and are being modified to permit monitoring of water relations in soils with a minimum effort by personnel from each project. On the basis of water content-water potential measurements already made or being made, it will be possible to monitor water potential as well as water content with neutron moisture and gamma density measurements. This information will be related to measurements of rainfall and interception along with plant growth, streamflow and ground-water levels over time after precipitation events of various magnitudes and intensities. This work will be done in cooperation with the rainfall-runoff modeling project of George Leavesley. Water relations will also be defined for some rangeland soils in California, Utah, Nevada, and Wyoming that have been previously investigated to determine if climate- or management-induced changes have occurred over the past 10 to 20 years.

D. Report Plans: Open-file or WRI reports will be prepared describing modeling procedures for each basin or group of basins and for the climatic regions represented. A final Professional Paper report making comparisons among regions is contemplated.

E. Distribution of Funds:

Salaries	$58,660
Travel	3,520
Supplies and Equipment	3,100
Data Processing	1,840
Vehicles	1,780
Total:	$68,900

II. Infiltration, Runoff and Sediment Production (AA-602-PP1-31)

A. Location: Central Region. During FY 1981, rainfall-simulation investigations by USGS will be concentrated on the operation of a small watershed study near Byers, Colorado, designed to provide data for determining the applicability of rainfall simulation data in watershed modeling.

B. Objectives:

1. Determine the values of variables and parameters in the Green-Ampt equation and the spatial variability of these values within simulator plots.

2. Determine means of relating Green-Ampt equation variables and parameters to measurable physical properties of the plots.

3. Determine the effects of rainfall intensity on sediment yield and infiltration.

4. Determine equivalence of natural versus simulated events.

5. Determine transferability of data from small plots to larger watersheds using rainfall-runoff models.

C. Procedures:

1. Procedures for objective one will involve measuring progress of the wetting front at numerous locations within plots as well as measuring soil-moisture content at selected sites. Final instrumentation will have to be developed for measuring these variables but present plans are to use thermistors for tracking progress of the wetting front and nuclear equipment to measure soil moisture.

2. Statistical methods will be used to determine the relationship, if any, between infiltration and soil moisture and physical properties, such as soil texture or vegetative cover that can be measured easily in the field.

3. Objective three will involve varying the application rate of simulated rainfall. Equipment has been or will be acquired to vary the rainfall rate between 0.5 and 4.0 inches per hour.

4. Three simulation plots have been selected and equipped with equipment for measuring rainfall, runoff, and sediment yield on a continuous basis. These data obtained from natural rainfall events will be compared with results obtained from simulated rainfall events to determine their comparibility.

5. Four locations have been selected and measuring equipment installed for determining runoff and sediment yield from tributaries of a 7.0-square mile watershed near Byers, Colorado. Data derived from simulator plots within this watershed will be used as input to the rainfall-runoff model being developed by the Geological Survey. Results of this modeling will be compared with measured runoff from the large area.

D. Reports:

1. A verbal report will be made to the Bureau just prior to the start of the 1981 field season to alert the COAR that fieldwork is about to begin.

2. A report will be prepared at the end of FY 81 field season outlining progress during the year and including a summary of data collected and what has been learned to date.

E. Relation to Other Studies: Rainfall-simulation data obtained during the fall of 1980 and summer of 1981 will be used in a rainfall-runoff modeling effort (in another section of Central Region work statement).

F. Distribution of BLM Funds:

Salaries--professional and technical		$25,000
Travel		2,000
Vehicles		1,875
	Subtotal:	$28,875
WOTSC		5,075
Admin. Service Charges		1,050
	Total:	$35,000

Precipitation - Runoff Modeling Project

I. Baseflow Analysis of Major Streams in Federal Coal Regions

A. Location: Major streams within the Green River-Hams Fork, Uinta-Southwestern Utah, Powder River, Southern Appalachia, San Juan, Fort Union, Western Interior, and Denver-Raton Mesa Federal coal regions.

B. Objectives: To (1) quantitatively describe the baseflow characteristics of the major streams in the above-named coal regions, relating these characteristics to regional geology and climate controls, and (2), using information developed from (1), investigate various predictive relationships that will allow for improved modeling of the baseflow portion of stream hydrographs in the coal regions.

C. Approach: Streamflow data from established stations will be used. No additional field data collection will be required.

The project investigator for this project is a professor of watershed hydrology on sabbatical leave from Colorado State University. He will submit a detailed study plan to the GS and BLM in January.

D. Report Products: A report on the stream baseflow characteristics of the major Federal coal regions will be prepared at the termination of the study.

E. Distribution of Funds:

Salaries	$20,980
Travel	420
Data Processing	1,800
Total:	$23,200

BRANCH of REGIONAL GEOCHEMISTRY

ANNUAL WORK PLAN

October 1, 1980 - September 30, 1981

The General Agreement between the Bureau of Land Management (BLM) and the Geological Survey, (GS), dated August 15, 1974, is considered an integral part of the Work Plan.

Purpose and Scope of Program

Assistance by the Branch of Regional Geochemistry of the GS to the Energy Minerals Rehabilitation Inventory and Analysis (EMRIA) program administered by BLM includes the following work and study elements:

A. Characterize the chemical and mineralogical composition of the rock materials that are overburden to mineable coal beds in northeastern Oklahoma. Analyses will include total element chemistry as well as chemistry of solution extracts of the rock materials. A report will be submitted to BLM evaluating these chemical and mineralogical data in the context of defining any potential rehabilitation problems.

B. Continued chemical extract work and interpretative analysis on samples collected from the energy study area, Utah. Emphasis will be placed on the chemical characterization of certain geologic units in the context of defining any potential rehabilitation problems. The potential transfer of this information to other areas in the West where coals of Cretaceous age are to be mined will be evaluated.

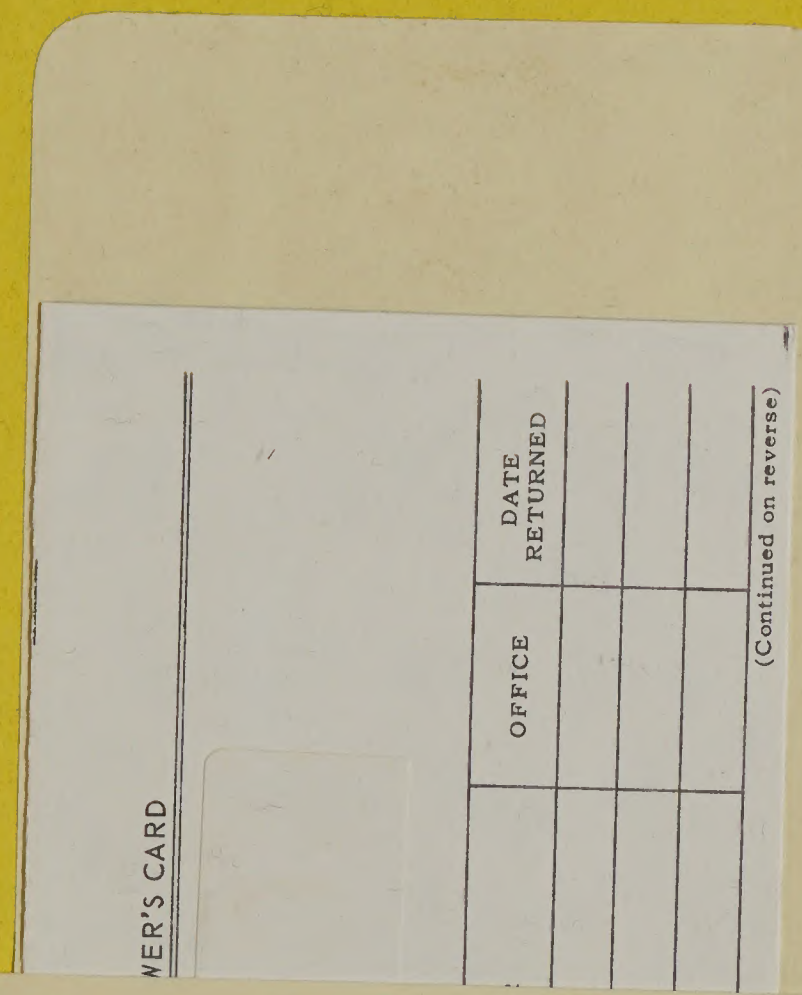
C. BLM personnel have requested continued consultative guidance for work in the Black Warrior Basin, Alabama.

D. Characterize the chemical and mineralogical composition of clinker materials that are associated with mineable coal beds in North Dakota, Montana, Wyoming, Colorado, and Utah. Total element chemistry as well as solution extract chemistry will be completed on selected clinker materials. A report will be submitted to BLM evaluating these chemical and mineralogical data in relation to any potential rehabilitation problems (revegetation and water quality) that they may create.

FUNDING

	Study Element			
	A	B	C	D
Salaries	$ 5,700	$ 8,500	$2,000	$16,100
Travel and O/E	---	1,000	1,000	2,500
Chemical Analyses	---	10,000	---	25,000
Mineralogical Analyses	---	1,000	---	2,000
Computer	2,000	1,000	---	1,000
Overhead	2,500	6,500	1,000	11,200
Totals:	$10,200	$28,000	$4,000	$57,800

GRAND TOTAL: $100,000



BLM LIBRARY
SC-324A, BLDG. 50
DENVER FEDERAL CENTER
P. O. BOX 25047
DENVER, CO 80225-0047